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Historical trends of tuna catches in the world

Cover photograph:
Trap fishing near Gibraltar. Courtesy of P. Miyake

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by

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Preparation of this document

This paper was prepared to document historical trends of tuna catches at global and regional scales. In the 1990s these trends deviated from those of total world production of all other fish species from capture fisheries, which reversed its long-term upward trend, while the total tuna catch has continued increasing. The development of the world and Atlantic tuna fisheries and their catches were documented by Dr Peter Miyake, while those of the Indian and Pacific fisheries are described by Drs Hideki Nakano and Naozumi Miyabe, respectively. The authors are grateful to Mr Nick Webb for editing the paper for language.

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Abstract

This paper reviews historical trends (mostly 1950–2000) of the catches of the major commercial species of tunas in the world (albacore, bigeye, bluefin, skipjack, and yellowfin). The total world catch of these species has increased continuously and almost tenfold during the last 50 years (from 0.4 to 3.9 million metric tons), but the pattern of increase has varied among species, oceans and fishing gears. The causes of those variations are, in most cases, interpretable, and are analysed as much as possible in this paper.

In world catch data, the Pacific Ocean has been predominant throughout. The rate of increase for the Atlantic catch has been much slower than those of the other oceans, and in fact the catches from of the Indian Ocean have exceeded those of the Atlantic since 1998. Currently the proportions of the total catch are about 15, 20 and 65 percent for the Atlantic, Indian and Pacific Oceans, respectively.

Since the late 1960s, by far the largest quantities taken have been skipjack, followed by yellowfin. The catches of both species show rapid increase, but that of yellowfin seems to have levelled off in the 1990s at 1 to 1.2 million tonnes (over 25 percent of the total), while the skipjack catch is still growing, reaching a record of 2 million tonnes (almost 50 percent of the total) in 1999. Bigeye catches also showed a constant increase, but at a lower level. The catches of albacore, bluefin and southern bluefin tunas have been stable or have decreased in recent years.

The catch of the purse-seine fishery, which targets mostly yellowfin and skipjack, became significant only in the late 1950s, and increased at an accelerated rate until 1990. The baitboat fishery took the greatest proportion of the total catches during the 1950s, but was overtaken by longline catches in the 1960s; however, baitboat catch showed another sharp increase in the 1970s. Longline catches started picking up in the late 1950s, increased gradually until 1990, then showed a relatively sharp increase until 1993 and thereafter declined. Longliners used to target yellowfin and albacore, but most of the large-scale longliners now target bluefin, southern bluefin and, most importantly in terms of quantity, bigeye tuna.

Japanese catches are by far the largest, and the majority of these are from the Pacific. United States catches were quite stable until the late 1960s, started increasing in the early 1970s, and eventually stabilized at about 200 000 tonnes. Longliners from other Asian nations showed good increases in the 1960s and 1970s. In recent years, many new players, including a large number of European countries with purse-seine fisheries, have become very important.

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Acronyms and codes

ATL	Atlantic Ocean
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CWP	Coordinating Working Party on Fishery Statistics
FAD	Fish aggregating device
FOC	Flag of convenience
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IND	Indian Ocean
IOTC	Indian Ocean Tuna Commission
ISC	Interim Scientific Committee on Tunas and Tuna-like Species in the North Pacific
IUU	Illegal, unreported and unregulated
MED	Mediterranean Sea
NEI	Nowhere else included (mostly "flag of convenience")
PAC	Pacific Ocean
SPC	Secretariat of the Pacific Community
TAC	Total allowable catch

Gear codes

BB	Baitboat ("Baitboat" is used exclusively for "Pole and Line")
GILL	Gillnet
LL	Longline
OTH	Other gears
PS	Purse seine
SURF	Surface gears
TRAP	Trap
TROL	Troll

Species codes

ALB	Albacore (*Thunnus alalunga*)
BET	Bigeye tuna (*Thunnus obesus*)
BFT	Atlantic bluefin tuna (*Thunnus thynnus*)
PBF	Pacific bluefin tuna (*Thunnus orientalis*)
SBT	Southern bluefin tuna (*Thunnus maccoyii*)
SKJ	Skipjack tuna (*Katsuwonus pelamis*)
SWO	Swordfish (*Xiphias gladius*)
YFT	Yellowfin tuna (*Thunnus albacares*)

1. Development of world tuna fisheries

It is important to understand the general trends and any large changes in the history of world tuna fisheries before reviewing the catch trends of each species of tunas by gear and country. Therefore, a brief review of major historical developments is provided here. Trends in fishing and catches, by oceans, species, stocks, gears and countries, are reviewed in detail in later sections.

In this report, the term "catch" does not necessarily include all discards, while "landing" means reported landings, not including discards. Basically, only the five major species of tunas (albacore, bigeye, bluefin, skipjack and yellowfin) are included in the analysis of aggregated tuna catches in this study. Therefore, "major tunas" refer to these five species, unless otherwise noted.

At a recent meeting of the Coordinating Working Party on Fishery Statistics (CWP), it was decided that Atlantic and Pacific bluefin tuna are different species (*Thunnus thynnus* and *T. orientalis*, respectively). However, the statistics in the past have treated them as one species, and since their appearance is the same and treated as one species in the market, they are not separated in this analysis.

Southern bluefin tuna is dealt with in a separate section, as there is only one stock common to all three oceans; therefore, the species is not described in the sections for individual oceans.

Swordfish is not included in the aggregated catches, but is discussed as an individual species owing to its importance in the tuna fishery, as by-catch or as a target species. However, as information on swordfish in the Pacific is not complete, the species is not discussed for that ocean nor for the world.

As to the fleet, the distinction between "NEI" and "Others" should be clearly understood. "NEI" catches are those not reported, and hence are mostly estimates made by scientists using trade data and port sampling, while "Others" means reported catches by unknown or mixed countries. Since the NEI catches are by vessels of various flags but mostly of the same owners, and have a very specific meaning in relation to the conservation of tunas, they are treated as a country.

The longline fishery can be categorized into large-scale (pelagic) and small-scale (coastal) fleets. In this report, "large-scale" refers to longliners over 24 metres in total length, over 200 GT, and equipped with freezers. "Longline" generally refers to large-scale longline, unless specified as coastal, artisanal, etc., for which statistics are generally available only in aggregated form.

In the analysis and figures by gear, "major fishing gears" refers to longline, purse seine and baitboat. Other gears are included in "others", which also includes unclassified gears.

The "main fishing fleets" for the various species and oceans, referred to in the text and illustrated in the figures, are classified by their accumulative catches during the 1950–2000 period.

1.1 BRIEF REVIEW OF DEVELOPMENT OF TUNA FISHERIES OF THE WORLD

1.1.1 Pre-1950

Since the nineteenth century, and indeed since ancient times, tuna fishing has been carried out in many places in the world. These fisheries were local, and generally near coasts. As most species of tunas are highly migratory, these fisheries caught tunas only at certain points in their life cycle, and thus had to be seasonal. They included, in the Atlantic, purse seining for bluefin off Norway, trolling for albacore in the Bay of Biscay, trap fishing in the Straits of Gibraltar and along the North African coast, fishing for bigeye and skipjack near islands and artisanal fishing along the coasts of Africa. Also, fisheries for swordfish have existed for a long time in the northwestern Atlantic and in the Mediterranean.

In the Pacific, there were various artisanal fisheries near islands in tropical waters, troll fisheries for albacore and baitboat fisheries for yellowfin and skipjack off the west coast of the United States of America, baitboat fisheries for skipjack near Japan, and many other fisheries for various tunas along the coasts of Japan. Coastal fisheries using baitboats and small seine nets existed off South America. In the Indian Ocean, fisheries for skipjack existed off Sri Lanka, India and the Maldives, and southern bluefin tuna were the target of longline fishing off Australia.

Besides the above, many artisanal fisheries for tuna-like fishes[1] existed in tropical or subtropical areas all over the world.

1.1.2 1950s

As a result of increasing demand for tuna for canning, industrial fisheries started during the 1940s and 1950s. In the 1950s, the major fisheries consisted of Japanese longliners and baitboats in the Pacific and United States baitboats off California and along the coasts of Mexico, while other traditional fisheries continued. After the Second World War the Japanese tuna fishery was limited to areas near its coast until 1952, but thereafter the fishery, particularly the longline fishery, expanded its fishing area very rapidly, and in the late 1950s reached the Atlantic Ocean.

Also, in the late 1950s, some European baitboats, based in local ports, started fishing off the African coast.

1.1.3 1960s

Spanish and French baitboats and purse seiners started fishing for tunas off tropical West Africa, and were joined by Japanese baitboats. Also, Japanese longliners expanded their fishing area all over the world, still targeting mostly albacore and yellowfin for canning. In the middle of this decade, the Republic of Korea and Taiwan Province of China started large-scale longline fisheries, learning the techniques from Japan, for exporting tuna to the canning industry. At the end of the decade, the Japanese longline industry developed extremely cold storage systems, which established new frozen products for the *sashimi* market, and consequently started to change their target species from yellowfin and albacore to bluefin and bigeye tunas.

In the Pacific, the US baitboat fishery off Central and South America was almost completely replaced by purse seiners, which developed a new fishing method, called dolphin fishing. Schools of yellowfin tuna associated with dolphins, a phenomenon observed only in the eastern Pacific, were their major target, and speedboats were used to chase the tuna into the net, together with the dolphins.

1.1.4 1970s

The purse-seine fishery by European nations in the tropical eastern Atlantic developed quickly, targeting yellowfin and skipjack.

Although the purse-seine fishery in the tropical eastern Pacific also continued to develop, strict regulations aimed at reducing the incidental mortality of dolphins in the fishery in this area led to US vessels changing flags to Central and South American countries, and also some of their effort shifted the central western Pacific, where there is no dolphin fishing.

---

[1] Includes all the species in FAO category 6 (tunas, bonitos and billfishes) except the major species analysed here (e.g. marlins, king mackerels, wahoo).

After the development of super-cold storage, the longline fishery gradually changed its target from yellowfin and albacore for canning to bigeye for *sashimi*. This shift was first seen among Japanese longliners only, but gradually expanded to the Korean and Taiwanese fleets. In order to catch adult bigeye, which live at much greater depths than yellowfin and albacore tunas, the hooks were set deeper and deeper (so-called "deep longlines"). This change in fishing strategy greatly affected the fishing areas and seasons, and the species compositions of catches, including by-catch species.

1.1.5 1980s

A new purse-seine fishery started in the western Indian Ocean, and an important portion of the fishing effort in the eastern Atlantic, particularly French purse seiners, moved to the Indian Ocean. In the Pacific Ocean, the purse-seine fishery expanded its fishing area, particularly in the central western Pacific. The efficiency of purse-seine fishing increased with the use of new equipment such as bird radar and helicopters.

During this decade, many new countries entered the large-scale industrial fisheries, mostly with purse seiners (e.g. Brazil, Mexico and Venezuela). Small-scale longline fishing operations also started in coastal countries in various areas (e.g. Mediterranean countries, Indonesia and the Philippines).

For the large-scale longliners, the Japanese and Korean fleets started to decrease in size, whereas the Taiwanese and "flag of convenience" (FOC) fleets increased rapidly. During this period, regional fishery management organizations introduced many management and regulatory measures for tuna fisheries, which affected fishing patterns and the distribution of catches among countries.

1.1.6 1990 to present

More and more management measures have been introduced, and illegal, unreported and unregulated (IUU) fishing practices have increased. IUU fishing became a major problem for the proper management of fisheries resources. In general, tuna-fishing capacity, including IUU vessels, increased extensively during this decade. Recent increases in catches have sometimes caused over-supply to the market, particularly for skipjack.

Small-scale longline fishing increased extensively, while the legal longline fishing industry started to limit its capacity.

Purse seiners started fishing with fish-aggregating devices (FADs) in the Atlantic in the early 1990s, and this method expanded to the Indian and Pacific Oceans. The FAD fishery is less selective than other fishing modes with regard to the species and size of the fish caught. Fishing efficiency, the size of the fish taken, the species compositions of the catch, and the by-catch of species caught incidentally have all changed drastically with the adoption of this fishing method.

Starting in the 1980s, and increasingly in the 1990s, many coastal states, in all oceans, started new tuna fisheries by chartering FOC boats. Some of these vessels changed flag to the coastal state that chartered them, and possibly this tendency will be intensified in the near future. Partially due to the development of these new coastal fisheries, the fishing effort by traditional longline countries started to decline.

In this decade, tuna farming (keeping tuna in captivity for a short time for fattening purposes) started as a new industry. This business resulted in increasing price and demand for specific sizes and species of tunas, and hence affected fisheries to a great extent: the relatively small tunas taken by purse seiners that used to be sold only to the canning industry can be now converted to products for the sashimi market. Currently, the main species used in farming is bluefin tuna, but the practice is spreading to bigeye and yellowfin tuna.

1.2 DATA SOURCES AND PREPARATION

The data sources used for this study vary among oceans. As far as possible, data prepared by regional agencies, such as the International Commission for the Conservation of Atlantic Tunas (ICCAT), Indian Ocean Tuna Commission (IOTC), Inter-American Tropical Tuna Commission (IATTC), Secretariat of the Pacific Community (SPC), Commission for the Conservation of Southern Bluefin Tuna (CCSBT) and Interim Scientific Committee on Tunas and Tuna-like Species in the North Pacific (ISC), as of October, 2002 were used. The FAO database (FISHSTAT PLUS) and national statistics were used to provide missing data. The individual data source for each region is discussed in the corresponding chapter. In principle, the 1950–2000 period is covered by these data.

In this report, the borders between oceans follow the decision by the CWP. Each ocean includes all adjacent seas (e.g. the Atlantic Ocean includes the Mediterranean Sea).

The data are analysed by species, gear and country. Often, particularly for the Pacific, data are not available by gear, region and/or country, but only in aggregated form, and hence the sum of each category may not match to the total catches by species.

1.2.1 General trends

Figures 1.1 and 1.2 show the combined reported catches of the major tuna species in three oceans, cumulatively and separately, from 1950 to 2000. The data for 1950 and 1951 might be incomplete, and those for 1999 and 2000 are still incomplete and tentative.

The total catch increased steadily from about 400 000 metric tons (tonnes) in 1950 to almost 4 million tonnes in 1999. Figure 1.2 shows that the catches in the Pacific have been predominant throughout the period. Both the Pacific and Indian Ocean catches have shown rapid increases in recent years, except for the last one or two years. However, the data for 2000, and possibly 1999 as well, are still incomplete. The rate of increase for the Atlantic catch is much slower than those of other oceans, and in fact the catches from the Indian Ocean have exceeded those from the Atlantic since 1989. Currently, the Atlantic, Indian and Pacific Oceans produce about 15, 20 and 65 percent, respectively of the total catch. It should be noted that catches of Atlantic bluefin, bigeye and albacore and eastern Pacific yellowfin and bigeye have been under some restrictions, while such regulations do not exist in other oceans, except for southern bluefin tuna.

FIGURE 1.1
World catches of major tuna species, cumulative, by oceans

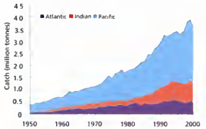
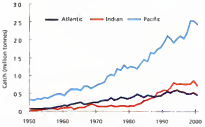


FIGURE 1.2
World catches of major tuna species in three oceans



1.2.2 Catch by species

Figures 1.3 and 1.4 show the combined world catches of the major species of tunas and their composition by species, respectively. Since the late 1960s, the largest component by far has been skipjack, followed by yellowfin.

Catches of both species have shown rapid increases throughout, but those of yellowfin seem to have levelled off in the 1990s at 1 to 1.2 million tonnes (over 25 percent of the total), while catches of skipjack are still growing, reached a record of 2 million tonnes in 1999 (almost 50 percent of the total). Bigeye catches also showed a constant increase, although at a much lower level than those of yellowfin and skipjack. The catches of albacore, bluefin and southern bluefin have been stable or decreasing, at much lower levels in the case of southern bluefin.

1.2.3 Catch by fishing gear

Figure 1.5 shows the combined world catches of major tuna species by the three main fishing gears (purse seines, baitboats, and longlines). The purse-seine catches show the largest increase, from almost nil in 1950 to 2.2 million tonnes in 2000. They became significant only in the late 1950s, and increased at an accelerating rate until 1990, after which the rate of increase showed some slowing down. Purse seines fish mostly in the tropical waters of the three oceans, targeting yellowfin and skipjack, but bigeye catches have become significant in recent years.

Baitboat catches used to be the greatest during the 1950s, but were overtaken by longline catches in the 1960s. In the 1970s they increased sharply, exceeding longline catches again, and have stabilized at about 500 000 tonnes since then.

Longline catches started picking up in the late 1950s, increased gradually until 1990, then rose relatively sharply until 1993, and thereafter have been declining. The earlier catches were almost exclusively by industrial offshore (pelagic) longliners of Asian countries, while the recent increase came from the development of coastal small-scale longliners. Longliners used to target yellowfin and albacore, but now most of the pelagic longliners target bluefin, southern bluefin and, more importantly in terms of quantity, bigeye.

FIGURE 1.3
World catches of major tuna species, by species

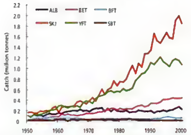


FIGURE 1.4
Composition of world tuna catches, by species

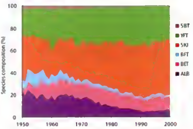
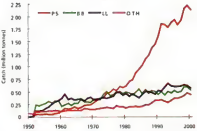


FIGURE 1.5
Combined world catches of major tuna species, by fishing gear



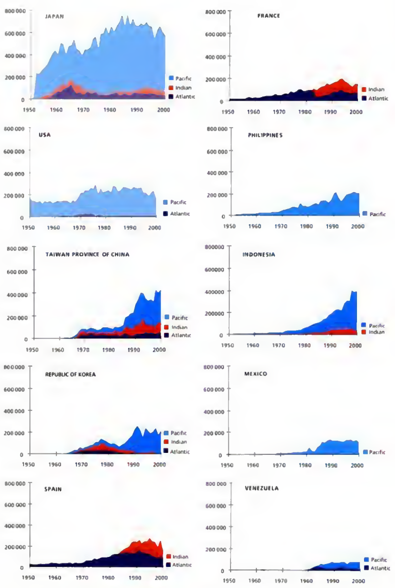
Recent increases in the catches of "other" fisheries are due to the increase in catches by artisanal fisheries (e.g. trolling, gillnet, handlines and miscellaneous unclassified gears) developed in coastal and island areas.

1.2.4 Catches by country

The combined catches of the five main tuna species (albacore, bigeye, bluefin, skipjack and yellowfin) from the world oceans during 1950–2000 by the ten main fishing fleets are shown in Figure 1.6.

FIGURE 1.6

Combined catches of major tuna species, cumulative, by oceans, by the ten main fishing fleets, 1950–2000 (tonnes)



Japanese catches are by far the largest, and the great majority of these are from the Pacific. They show a sharp increase from the 1950s to the mid-1960s, reaching a first peak of about 550 000 tonnes in 1965, resulting from the increased catch in the Atlantic Ocean by longliners and baitboats. The Atlantic catch then declined, particularly after the baitboats based in Tema, Ghana, retired from the fishery, and the total catch declined until 1970. It then started increasing again until the mid-1980s to a second peak of about 750 000 tonnes, mostly due to the increase in the catches in the Pacific by purse seiners and baitboats. Since the mid-1980s the catch has declined. Overall, the Japanese share of the catch has been declining, as the total world catch has been increasing at a higher rate than the Japanese fishery.

United States catches were quite stable until the late 1960s. They started increasing in the early 1970s as the purse-seine fishery developed in the eastern tropical Pacific, and then stabilized again at a level of about 200 000 tonnes, in part because many US-built boats were sold to other countries during this period.

Taiwan Province of China started longline fishing only in the late 1960s, and increased its catch rapidly in all three oceans. During the 1970s and 1980s, its catch stabilized at a level of less than 100 000 tonnes. In the late 1980s it increased sharply to over 300 000 tonnes, due to the initiation of a purse-seine fishery and the expansion of its longline fleet. In the 1990s the level remained slightly below 400 000 tonnes. The fleet has been operating in all three oceans, but the share of the catch from the Pacific has increased in recent years.

The **Republic of Korea** also started fishing in the 1960s with longliners, and its catch increased rapidly until the mid-1970s, fishing in three oceans. As the longline activity was reduced, the catch declined as well until 1985, when the purse-seine fishery started in the Pacific. Consequently the catch jumped up to the level of 100 000 tonnes, and has been maintained at that level.

Spain and **France** show very similar trends. Until the early 1980s, their catches were limited to the Atlantic; then their purse seiners established fisheries for tropical tunas in the western Indian Ocean, and their catches almost doubled.

The **Philippines** and **Indonesia** show very similar patterns of the growth of catches. Since 1970 their catches have increased steadily, and recently were near 200 000 tonnes and 400 000 tonnes, respectively. The Philippine catch comes mostly from the Pacific, while Indonesian catches come from the Pacific and Indian Oceans.

Mexico and **Venezuela** also had traditional (artisanal and some industrial) fisheries, mostly in the Atlantic, but with very low catch levels. Since the early 1980s their catches have increased rapidly in the eastern Pacific.

2. Development of the Atlantic tuna fisheries

2.1 DATA SOURCES AND PREPARATION

The data source used in this study is ICCAT FISHSTAT Plus, 2002 version (updated in October 2002), which includes data for 2000. Although the term "catch" is used in the text, most of the data are landings, but sometimes include partially reported discards. Reported data for recreational fishing are included.

2.2 GENERAL OVERVIEW

2.2.1 Total catch

Figure 2.1 shows the combined reported catches of the major tunas, 1950–2000. The catches increased almost steadily from 1950 until 1994, when they peaked at nearly 600 000 tonnes, and thereafter declined. At least a part of the recent decline is due to ICCAT management measures.

2.2.2 Catch by species

Figure 2.2 shows the Atlantic catches, by species, and Figure 2.3 the species compositions of these catches. The catch trends for each species are discussed in the following sections; only their relative importance is described in this section.

Until the late 1950s, only bluefin and albacore were intensively exploited in the Atlantic, and the catches of the two species were about even. However, in the late 1950s, when a large-scale longline fishery (mostly by Asian boats) developed in the Atlantic, the catches of the initial target species, yellowfin and albacore, started increasing very rapidly (Figure 2.4). The albacore catch increased until 1970, and it was for a period the most important species, as it was taken by both longlines and surface gears. However, since 1972, with the development of the surface fishery (baitboats and purse seines), the yellowfin catch has continued to increase, while the albacore catch has stabilized. The yellowfin catch was the greatest until 1991, when it was exceeded by the skipjack catch.

FIGURE 2.1
Catches of major tuna species in the Atlantic Ocean

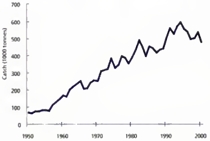


FIGURE 2.2
Catches of major tuna species in the Atlantic Ocean, by species

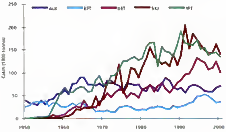


FIGURE 2.3
Species composition of the Atlantic catches of major tuna species

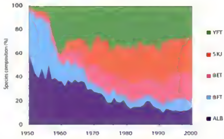
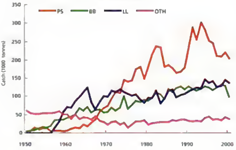


FIGURE 2.4
Catches of major tuna species in the Atlantic Ocean, by fishing gear



It should be noted that bluefin has been under ICCAT catch restrictions since 1981. All other species except skipjack have also been under some kind of regulation (size, effort, or catch level), which has in all probability affected the catch trends.

2.2.3 Catch by fishing gear

Figure 2.4 shows the combined Atlantic catch of major species, by fishing gears. The large-scale longline fishery was started in 1957 by a Japanese experimental fishing boat off Venezuela. Japanese longliners followed the experimental boat that same year, and in 1958 found a good fishing ground for bluefin off Brazil.

When the bluefin distribution patters changed in the mid-1960s, the fleet expanded the fishing ground to the west and northwest, targeting yellowfin and albacore, and was followed by fleets from the Republic of Korea and Taiwan Province of China. The catch reached its first peak in 1965. The boats at that period were equipped with freezers of about -25 °C, and the catches were exported for canning. In the early 1970s, the longliners started changing their strategy: equipped with super-cold freezers (-40 to -55 °C), they started fishing for the Japanese *sashimi* market. As bluefin and bigeye tunas are the most valuable species for this market, the target shifted from yellowfin and albacore to these species, and the longlines were set in the deeper layer of the water where large bigeye live. Such changes were seen first in the Japanese longliners, and much later in Korean and Taiwanese boats.

The longline catch declined in the late 1970s, but later rose again and stabilized until the early 1990s. Besides these Asian longline fleets, swordfish longline fishing also has developed since the 1970s (see Sections 2.8 and 3.7). In the 1990s many longliners operating under flags of convenience (FOC) and/or engaging in illegal, unreported and unregulated (IUU) fishing started fishing in the Atlantic, and are partially responsible for the increases in longline catches and in bigeye catches.

The baitboat fishery initially fished mostly for bigeye, and some bluefin and albacore, in areas near islands, such as the Canaries, Madeira and the Azores. In the late 1960s, this fishery started to expand into the eastern tropical Atlantic, targeting yellowfin and skipjack, and since then the catch has increased gradually but steadily. In particular, the fishery in the Gulf of Guinea, based in Ghana, has been very important.

A purse-seine fishery for bluefin existed in the 1950s to 1960s in the northeastern Atlantic, but this disappeared when bluefin no longer migrated in the northeastern Atlantic, probably because this area was on the margins of the distribution of the species. On the other hand, the purse-seine fishery that started in the eastern tropical

Atlantic in the late 1960s developed very rapidly. In the early- to mid-1980s the catch rate dropped in this area, and many of the seiners moved to the new fishing grounds being developed in the western Indian Ocean. However, at the beginning of the 1990s the catch rate recovered very quickly and increased further. At about the same time, fish-aggregating devices (FADs) were introduced in the Atlantic. As the efficiency of this fishing method is very high, this fishery developed very fast. Purse seiners started catching juvenile tunas in mixed-species aggregations around FADs, which resulted in a further increase in bigeye catches. Also, in the 1970s a purse-seine fishery for bluefin started in the Mediterranean area, and the catches by this fishery increased very rapidly (Figure 2.2).

Other gears used to catch tunas in the Atlantic include traps, harpoons, trolls, pelagic trawls, handlines, gillnets and other, unclassified gears. In the early years, these other catches consisted mostly of bluefin caught with traps. Also, improvements in data collection reduced the catches assigned to the "other" gears' catches in more recent years.

2.2.4 Catches by country

The combined catches of the major tunas from the Atlantic Ocean during 1950-2000 by the ten main fishing fleets are shown in Figure 2.5. **Spanish** catches have been made by traditional fishing methods (e.g. trap fishery for bluefin, troll fishery for albacore, and baitboat fishery for bigeye), as well as by the more recently developed industrial purse-seine fishery for skipjack and yellowfin and the longline fishery for swordfish. The Spanish catch peaked at the beginning of the 1990s and then declined, mostly due to various ICCAT regulations.

France had a traditional troll fishery for albacore, but recently its major catches have been made by purse seiners fishing for yellowfin and skipjack in tropical waters and, to a lesser extent, for bluefin in the Mediterranean. Therefore its catch trend is very similar to that of its purse seiners. The drop in catch in 1984 is due to the shift of the seiners to the Indian Ocean. The **Japanese** catch is almost exclusively longline, except for some tropical baitboat fishing in the 1970s. The peak in the 1960s reflects the catches of yellowfin, skipjack and albacore for canning. **Taiwanese** and **Korean** fisheries are exclusively longline, except for a couple of years by Taiwanese drift gillnets. The **Ghanaian** catch is almost all by baitboats, and in the latter half of the 1990s also by purse seine.

2.3 ALBACORE

2.3.1 General overview

The fisheries for albacore are distributed throughout the Atlantic between 55°N and 45°S and in the Mediterranean Sea. The spawning areas are in the western subtropical areas of both hemispheres in the Atlantic and throughout the Mediterranean. The distribution in the Atlantic is split between the northern and southern hemispheres, and albacore is thus considered as two separate stocks, with Mediterranean albacore as another independent stock.

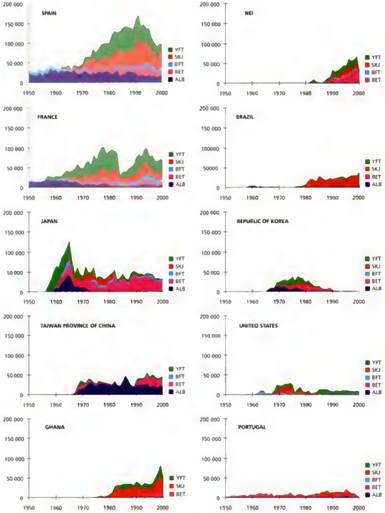
Figure 2.6 shows the catches of Atlantic albacore, total and by stock, and Figure 2.7 the catches of the northern and southern stocks, by fishing gear. Figure 2.8 shows the albacore catches, by stock, by the ten main fishing fleets during 1950–2000.

Northern stock

The northern stock has been exploited historically for a long period, mostly by trolling in the Bay of Biscay. The catches consist of young fish. The catch level was about 30 000 to 40 000 tonnes (Figure 2.7). In the late 1950s, when Asian longliners, initially from Japan and, from the mid-1960s, the Republic of Korea and Taiwan Province of China, started fishing for adult albacore on the high seas, the catches rose to 50–60 000 tonnes. However, as the longline fishery gradually shifted towards bluefin and bigeye tuna

FIGURE 2.5

Atlantic catches (tonnes) of major tuna species by the ten main fishing fleets



over the last 20 years, the catch has been in a declining trend. Surface fisheries have maintained their catch levels, but the troll fishery has been gradually replaced by baitboats and, later, by drift gillnet[2] fisheries.

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[2] The European Commission has prohibited all fishing with drift gillnets since 2002.

FIGURE 2.6

Catches of albacore in the Atlantic, total and by stock

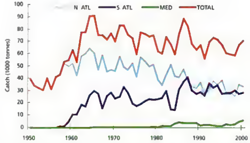
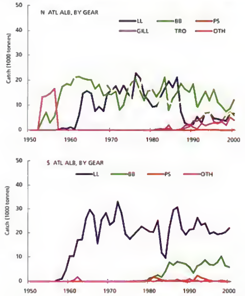


FIGURE 2.7

Catches of North and South Atlantic albacore, by fishing gear



Southern stock

Exploitation of the southern stock started with longliners in the late 1950s. From the mid-1960s to the 1980s catches were at least about 20 000 tonnes (Figure 2.7). Since the surface fishery started in the mid-1980s, there was a general increase in the total catch of southern albacore. Recently, due to ICCAT regulations, the increasing trend has been halted.

Mediterranean stock

In general, the catch statistics have shown an upward trend since the early 1980s with much fluctuation (maximum about 5 000 tonnes). However, the statistics are not reliable, and the apparent fluctuations in the catch may simply reflect changes in the reporting rate.

2.3.2 Catch by fishing gears

Troll fishery

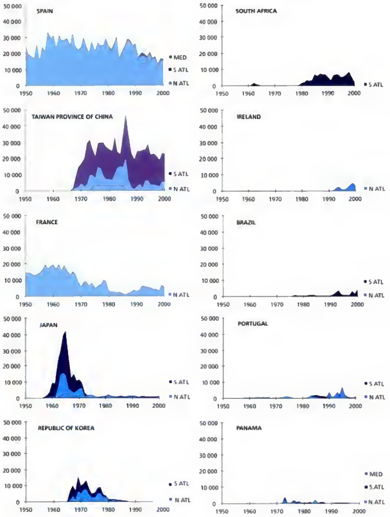
North: The troll fishery for albacore by French and Spanish fishers in the Bay of Biscay has existed since the early nineteenth century. Prior to the 1950s, the troll catch in the north Atlantic was quite high (30 to 40 000 tonnes) and stable. This high level was maintained until the early 1960s. The catch attributed to "other" gears for 1952–55 should have been attributed to trolling. Since the late 1950s, it has declined steadily, due to the conversion of Spanish troll vessels to bait fishing since the mid-1950s and of French troll vessels to mid-water trawling and drift gillnet fishing since the late 1980s.

South: There has been no troll fishing in the South Atlantic.

Baitboat fishery

North: Baitboat fishing started in 1950s, and catches increased very rapidly to the 20 000 tonnes level by the beginning of the 1960s. Since then, the baitboat catch has maintained this level, with annual fluctuations. The major component has been the Spanish fishery in the Bay of Biscay, which changes target species seasonally between

FIGURE 2.8
Albacore catches (tonnes) by the ten main fishing fleets in the Atlantic Ocean



albacore and bluefin tuna. There is also a Portuguese baitboat fishery around its island areas (Azores and Madeira). These fisheries undergo very large annual fluctuations, due to the variability in the availability of fish in the waters near the islands.

South: Baitboat fishing in the south was started in the early 1980s by the Portuguese fleet off Namibia and South Africa. This fishery developed quickly, and catches by Namibian and South African baitboats reached the level of 10 000 tonnes in recent years.

Longline fishery

Japan started a longline fishery in the Atlantic in the late 1950s. During its initial stage, Japanese longliners targeted bluefin off Brazil and later albacore, together with yellowfin tuna. Those fish were exported for canning. However, toward the end of the 1960s, the Japanese longliners equipped with super freezers changed the target species to bigeye tuna, deploying deep longline gears. The catches were mostly brought back to the Japanese *sashimi* market. For this reason, the albacore catches became only by-catches of bigeye or bluefin fishing. Korean and Taiwanese longliners started in the Atlantic several years after the Japanese longliners, targeting albacore in both the North and South Atlantic. Their catches increased in the late 1960s in the North Atlantic and in the early 1970s in the South, and the latter eventually exceeded the catches by these countries in the North Atlantic. Korean catches decreased rapidly in the late 1970s as their fleet started withdrawing from the Atlantic. However, the Taiwanese fleet has continued targeting albacore until now. Since early 1990s, a part of the Taiwanese fleet shifted its effort to bigeye for the Japanese *sashimi* market. Therefore, the total longline catches in the North Atlantic were high between the early 1960s and the mid-1980s, at a level of 10 000 to 20 000 tonnes, while those in the South Atlantic have been high from the late 1960s to the present, between 20 000 and 30 000 tonnes, with some annual fluctuations.

ICCAT started management measures for southern albacore in 1998, when it established the TAC. Up to now, this has had some effect on the total albacore catches in the south, and has possibly limited a further increase in the catches.

Longlining is also the major fishing method in the Mediterranean Sea; the major longlining countries are Italy, Spain and Greece. However, the statistics from that area have not been reliable.

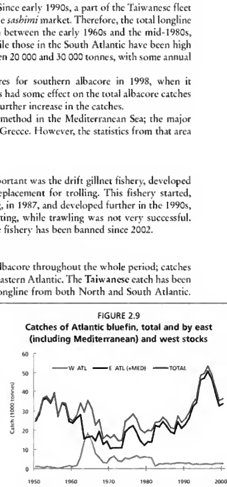
Other fisheries

Among the other fisheries, the most important was the drift gillnet fishery, developed by France in the Bay of Biscay as a replacement for trolling. This fishery started, together with the paired pelagic trawling, in 1987, and developed further in the 1990s, with Ireland and England also participating, while trawling was not very successful. However, due to the EU regulations, the fishery has been banned since 2002.

2.3.3 Catches by country

Spain has been the largest producer of albacore throughout the whole period; catches are mostly made by trolling in the northeastern Atlantic. The **Taiwanese** catch has been high since the late 1960s, and is all by longline from both North and South Atlantic. **France** used to be important producer of albacore, but recent catch levels have been low. **Japan** had a high level of albacore catch in its initial longline fishing stage.

FIGURE 2.9
Catches of Atlantic bluefin, total and by east (including Mediterranean) and west stocks



2.4 ATLANTIC BLUEFIN TUNA

2.4.1 General overview

The fisheries for Atlantic bluefin tuna are currently distributed from the Gulf of Mexico to Newfoundland in the West Atlantic, from roughly the Canary Islands to south of Iceland in the East Atlantic, and throughout the Mediterranean Sea. Figure 2.9 shows the annual catches from the

FIGURE 2.10
Catches of Atlantic bluefin, cumulative, by stock

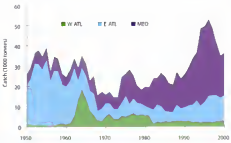
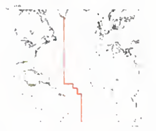


FIGURE 2.11
Hypothetical stock boundary for Atlantic bluefin



West and East Atlantic (including the Mediterranean), and Figure 2.10 the cumulative catches of the East Atlantic, Mediterranean and West Atlantic. There are two spawning grounds known in the Atlantic, one in the Gulf of Mexico and one in the Mediterranean Sea. Assuming that bluefin tuna have homing fidelity, and noting some discontinuity in the longline catches in the offshore area, in the 1970s ICCAT divided the population into eastern and western stocks (Figure 2.11). However, the overall distribution of the catch in 1990s is much more continuous across the North Atlantic than in previous decades. Tagging evidence indicates that movement of bluefin across the current east/west management boundary in the Atlantic does occur, and that it can be extensive (including trans-Atlantic) and complex. Management plans by ICCAT have been based on two stocks, but the Commission is now revisiting the problem of management units. Even though the bluefin tuna in the East Atlantic and the Mediterranean are considered to belong to the same stock, the fisheries in these two areas have been quite different.

The catches of bluefin from the Atlantic Ocean during 1950–2000 by the ten main fishing fleets are shown in Figure 2.12.

In general, the catch of bluefin in the East Atlantic has been greater than in the West; particularly until the end of the 1950s, the west catch was far less than the east catch. In the early 1960s, the west catch started increasing while the east catch declined, and in 1964 the west catch exceeded that of the east. However, the west catch declined very rapidly thereafter, while the east catch had increased very rapidly.

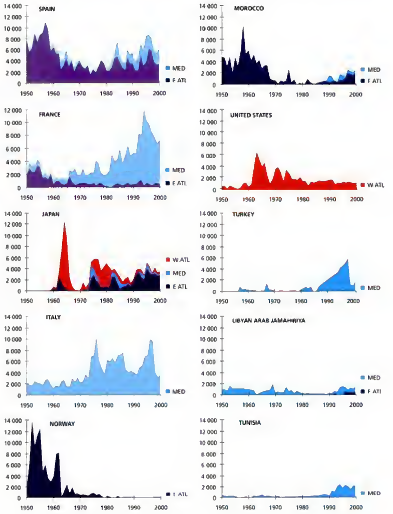
East stock (including Mediterranean)

The East Atlantic catch stayed at a fairly high level of 30 000 tonnes in the 1950s and into the early 1960s. The major gears were traps in the Mediterranean and near Gibraltar and purse seiners in the northeastern Atlantic. However, the trap catch peaked in 1958, and then declined sharply into the early 1960s. Purse-seine catches during this period were mostly made by the Norwegian fleet in the northeastern Atlantic: the catches showed large yearly fluctuations, declined very sharply in the early 1960s, and ceased in the 1970s.

Annual catches of bluefin by the Bay of Biscay baitboat fishery were at a relatively high level of about 4 to 5 thousand tonnes until the mid 1950s, then they dropped sharply to 1 to 2 thousand tonnes throughout the 1960s. The total Mediterranean bluefin catch was stable at 5 to 7 thousand tonnes until the mid-1970s, as the reductions of trap catches were compensated by increased gillnet and longline catches. Therefore,

FIGURE 2.12

Atlantic bluefin catches (tonnes) by the ten main fishing fleets in the Atlantic Ocean, by region



the overall catch of the east stock (including the Mediterranean catches) dropped to a lower level of 10 to 15 thousand tonnes from the early 1960s until 1973.

Starting in 1974, the Mediterranean catch showed a very rapid increase until it reached the first peak in 1976. Although the east Atlantic catch stayed at a low level of less than 10 000 tonnes, the overall catch from the eastern stock (Atlantic and the

Mediterranean) resumed its upward trend in the late 1970s, and after some decline in the early 1980s, increased very rapidly in the 1990s to a peak in 1996.

These increases in the bluefin catch in the East Atlantic (including the Mediterranean) were possibly the result of an increase in fishing effort, generated by the increasing demand for bluefin for the *sashimi* market. Until the 1970s, most of the bluefin caught in the Mediterranean and northeastern Atlantic by the coastal states was sold in the local European market for consumption as fresh fish and/or for canning, with some minor exceptions of trap catches of large fish just about to spawn, which were exported to the Japanese *sashimi* market. The longline catches by oriental longliners were also for the Japanese *sashimi* market.

Starting in the mid-1980s, Japan started importing fish caught by purse seiners, and as a result purse-seine effort has continued to increase. Also, more oriental longliners concentrated in the Atlantic near Gibraltar and in the Mediterranean, and their catches increased as well. In the 1990s, many IUU longliners joined the Mediterranean fishery, and their catches became very significant. Learning from these longliners, the coastal states (e.g. Spain and Italy) also developed bluefin longlining in the Mediterranean in the 1990s. In the meantime gillnet catches decreased, as a consequence of the ban on gillnets by the UN Resolution.

Bluefin tuna farming activities in the Mediterranean have had a strong effect on the increasing effort. Farming started in the 1980s in Ceuta, where spent lean large bluefin caught by traps were fattened and sent to the Japanese market. However, in the mid-1990s a new type of farming was developed in the Mediterranean, in which medium or small bluefin caught by purse seines were fattened and shipped to Japan. This product developed a new market in Japan and, in consequence, farming spread out in the Mediterranean and stimulated more interest in the purse-seine fishery.

The east bluefin catch has been under the ICCAT management scheme since 1995, and this is reflected by the reduction of the total reported catches since 1996.

West stock

The West Atlantic bluefin fisheries are not as traditional as in the east and the Mediterranean Sea, and catches used to be low. In the 1950s, the only fisheries were Canadian trap and harpoon fisheries and United States trap and recreational rod-and-reel fishing. When Japanese longliners started operating in the Atlantic in 1957, they found a high concentration of bluefin tuna in waters off Brazil. This fishery peaked in 1964 at well over 10 000 tonnes, but finished by the end of 1960s. Then the Japanese longliners found new grounds off New England and in the Gulf of Mexico, and their catches started increasing again in the late 1970s until 1981; however, their catches were now kept in super-freezers for the *sashimi* market, so they were two different types of fisheries.

The United States purse-seine fishery started in the late 1950s, and peaked in 1962 and again in 1970. The catch fluctuated widely during this period. The catches declined, due partly to domestic regulations, towards 1980. In the meantime, Canadian trap catches were reduced to almost nil. The catches of the US recreational rod-and-reel fishery started to increase substantially, though there were very wide fluctuations, particularly in the 1970s. The large fish caught in this fishery have been sold to the Japanese *sashimi* market.

ICCAT adopted strict catch quota regulations for West Atlantic bluefin tuna in 1981, and these came into effect in 1982. As only three countries (Canada, Japan and the United States) were fishing bluefin in this area until recent years, and the regulations were strictly implemented, the catches since 1982 have corresponded to the total allowable catches set by ICCAT.

2.4.2 Catch by fishing gears

Bluefin tuna catches in the east (including Mediterranean) and west Atlantic, by fishing gears, are given in Figures 2.13 and 2.14, respectively.

Longline fishery

In the late 1950s Japanese longliners entered the Atlantic and started fishing for bluefin off Brazil. These longliners were equipped with normal freezers (about -20 °C) and catches were mostly exported for canning. In the early 1960s the catch increased very rapidly to a peak of over 12 000 tonnes in 1964, but in the late 1960s bluefin started disappearing from these waters. Around the same time, the Japanese longline fishing grounds started expanding towards the northeast, and reached the Bay of Biscay in the mid-1970s. As longliners with super-cold freezers (under -40 °C) started fishing for the *sashimi* market, the bluefin fishery in the western Atlantic, off New England in winter and in the Gulf of Mexico during the early summer spawning season, became very important. However, as ICCAT started a very stringent quota system in 1982 for the west bluefin stock, these fisheries became minimal.

Meanwhile, in the early 1980s Japanese longliners started fishing in the Atlantic near Gibraltar, and later in the Mediterranean, for spawning bluefin tuna. In the 1990s, as regulations on bluefin fishing were set by ICCAT, many IUU longliners entered the Mediterranean fishery and their catches became very significant. Learning from these longliners, the coastal states (e.g. Spain and Italy) also developed bluefin longlining in the Mediterranean in the 1990s. However, theft of fish and fishing gear in the Mediterranean became a widespread practice, and many Japanese boats left the Mediterranean in more recent years. Besides, since the early 1990s, a new fishing ground was developed in the north central Atlantic, east of the west-east boundary lines, and expanded further north to near Iceland and the Faeroe Islands in the late 1990s.

FIGURE2.13
Catches of Atlantic bluefin in the East Atlantic (including Mediterranean), by fishing gear

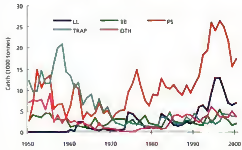
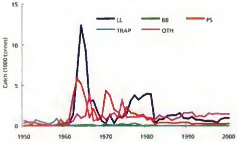


FIGURE 2.14
Catches of Atlantic bluefin in the West Atlantic, by fishing gear



Trap fishery

Some fisheries (definitely with traps and likely with gillnets) for bluefin tuna in the Mediterranean existed already in ancient Greece and Rome. More recently, until the end of the 1960s, one of the major bluefin fisheries was the trap fishery in the Atlantic near the Strait of Gibraltar and in the Mediterranean. The greatest catches were made by Spain on the Atlantic side of Gibraltar, followed by Italy, Tunisia and Morocco in the Mediterranean. However, these catches peaked in 1958, then declined sharply in the 1960s and stayed at a very low level during the 1970s. The major reason for the decline was the decreasing availability of fish to the traps. Catches recovered moderately in the 1980s, with large annual fluctuations.

In the western Atlantic, a minor trap fishery was operated in northeast Canada and also on the northeast coast of the United States, and this was almost the only bluefin fishery until 1957. Since then, the trap catch decreased almost to nil, and has never recovered.

Purse-seine fishery

From the 1930s to the mid-1960s, the Norwegian purse-seine fishery was as important as the trap fishery in the east bluefin catches. However, in the late 1960s bluefin started disappearing from Norwegian waters, and the fishery was almost terminated by the late 1970s.

In the West Atlantic, US purse seiners started fishing for bluefin towards the end of the 1950s, and the catch increased rapidly in the 1960s and 1970s. Particularly in the early 1970s, seiners caught a great number of small bluefin off the east coast of the United States. This fishery declined in the 1970s, and has been very minor since 1982 as a result of ICCAT and domestic quota regulations.

In the Mediterranean Sea, purse-seine fishing was started in 1966 by France, and it developed very quickly until 1977; it then levelled off until the mid-1980s, when other countries such as Spain and Italy joined the fishery. Thereafter, the catch started picking up very quickly, to reach a historical high in 1996. Since that peak the reported catch has been declining, most likely due to the catch quota set by ICCAT. In the 1990s, Croatia, Greece, Algeria, and Turkey also joined this fishery.

Baitboat fishery

The baitboat fishery in the Bay of Biscay was one of the important fisheries for east Atlantic bluefin even in the 1930s. This fishery has been conducted both by French and Spanish fishermen from the Basque area, and shows significant yearly fluctuations without any long-term trend.

Baitboat fisheries also exist in the Canary Islands and Madeira, and from time to time in the Azores Islands. However, the quantity of catch is minor.

In the Mediterranean area, some minor local baitboat fisheries have been developed by Spain, Greece and Morocco. The quantity of catches has been minor.

In the West Atlantic, a Canadian tended-line fishery (similar to the baitboat fishery) has developed since the mid-1980s, but again the catch quantity has been minor.

Other fisheries

Recreational fisheries for both small and large fish exist in the West Atlantic off the United States since the 1950s; they increased continuously until the beginning of the 1980s, when the catch quota was set for the west bluefin stocks. They also developed recently in the Mediterranean Sea.

Another important coastal fishery in the Mediterranean area is gillnet fishing. This type of fishery has been widely conducted in all the coastal areas of the Mediterranean Sea. However, it has been curtailed significantly after the UN Resolution to ban drift gillnets.

Harpoon fisheries exist on the east coasts of Canada and the United States and widely in the Mediterranean area. However, the catches are minor.

Handline fishing has been also developed widely along the Mediterranean coasts, and recently the catch has been increasing.

2.4.3 Catches by country

Since catches by countries are discussed under each gear and stock, only a very brief summary is given here. **Spain** has constantly had the greatest catches throughout the last 50 years. In the early years, most of the catches were by trap and baitboats in the Atlantic, and later by purse seiners and longliners in the Mediterranean. **France** and **Italy** have increased their catches since the mid-1970s in the Mediterranean, using purse seines.

The **Japanese** catch is solely by longline. The peak seen in the 1960s was off Brazil, while more recently catches were distributed evenly between both stocks. **Norway** and **Morocco** made big catches in the early period, by purse seine and various fishing methods, respectively. US catches are solely from the West Atlantic, and peaked in the early 1960s; the recent low level is due to ICCAT regulations.

2.5 BIGEYE TUNA

2.5.1 General overview

In the Atlantic bigeye tuna are widely distributed across the ocean, between 50°N and 45°S. The spawning area is in tropical waters. In general, juvenile fish form surface schools with other tropical tunas (mostly yellowfin and skipjack) in coastal waters, particularly in the Gulf of Guinea, but when they reach maturity they do not form dense schools and live at a much greater depth. ICCAT considers that there is a single stock of bigeye in the Atlantic.

Figure 2.15 shows the total cumulative Atlantic bigeye catches by fishing gears. Bigeye tuna are harvested by three major gears, baitboat, longline and purse seine, in that chronological order of entry into the fishery. Catches by all of these gears, and hence total catch in the Atlantic, increased steadily since 1950 to about 130 000 tonnes in 1994, and thereafter declined slightly. The recent decline in the catch may have been partly due to the various management measures taken by ICCAT.

2.5.2 Catch by fishing gears

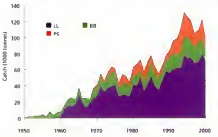
Baitboat fishery

There are two types of baitboat fisheries, one targeting large bigeye near the northeastern Atlantic islands (Azores, Madeira and Canaries), and another on schooling juveniles in the Gulf of Guinea. From 1950 up to the mid-1960s, most of the baitboat landings were of the first category, i.e. large fish near the islands, and hence by Spain and Portugal. The catch level of this fishery during that period was about 2 000 to 6 000 tonnes, with wide fluctuations due to the availability of fish near the islands. This fishery continues at present at a similar level.

The second fishery, for small bigeye, was started in 1962 by Japanese baitboats based in Tema, Ghana. Later, the Republic of Korea, Panama and Ghana joined this fishery. Currently only Ghana continues baitboat fishing in this area. These fisheries target yellowfin and skipjack, and bigeye is only by-catch, so the level of the bigeye catch is relatively low, about 1 000 to 2 000 tonnes.

FIGURE 2.15

Catches of bigeye in the Atlantic Ocean, by fishing gear



Longline fishery

The longline fishery in the Atlantic started with the Japanese exploratory fishing off Venezuela in 1957. From the mid-1960s to the 1970s, the Japanese longliners concentrated on yellowfin, albacore and bigeye for the canning industry. In the 1960s, the Republic of Korea and Taiwan Province of China followed Japan and started longline fishing. Their total bigeye catch was about 20 000 to 30 000 tonnes. In the late 1970s the Taiwanese fleet started concentrating on albacore in temperate waters, and its bigeye catch declined considerably, while the Korean fishery stayed in tropical waters.

In the late 1970s, the Japanese fleet changed target to bigeye for the *sashimi* market, as these fish are of higher value than yellowfin or albacore tunas, using deep longlines. Conversion to this type of longline also started in Taiwanese vessels at the beginning of the 1990s. However, some Taiwanese vessels are still targeting albacore, while almost all the Japanese vessels are targeting bigeye. The total catch of bigeye by these three countries was stable at 40 000 to 60 000 tonnes during the 1970s and 1980s, with an increasing trend in the 1990s.

In the Atlantic, longliners flying the "flags of convenience" were very commonly seen. Until the early 1990s, these flags were used mostly to avoid national regulations on licensing, labour conditions, etc., but since then the characteristics of the fleet have changed; those vessels fly "flags of convenience" in order not to comply with international management measures, and are thus considered IUU vessels. ICCAT has estimated that the catches of such vessels have increased sharply in the last 10 years to over 25 000 tonnes. As a result, the total longline catch has increased very sharply from the late 1980s to the present.

As ICCAT took several management measures, the longline catch has been stabilized at the high level of 70 000 to 80 000 tonnes in the last several years.

Purse-seine fishery

Purse seiners fishing in the Gulf of Guinea concentrate on the tropical tunas, yellowfin and skipjack. It is suspected that, until the late 1960s, some bigeye were mixed with yellowfin in the landings, but was reported as yellowfin. Distinguishing juvenile bigeye from yellowfin by appearance is difficult, and the commercial value of both species was the same, so the catches were not separated by species. Since the early 1970s bigeye landings have been reported separately, based on port sampling. Bigeye catches increased from the mid-1970s and stayed at the level of 10 000 to 15 000 tonnes in the early 1980s. In the mid-1980s the purse-seine effort in tropical waters dropped significantly, and accordingly the bigeye catch dropped to about 5 000 to 6 000 tonnes. However, in the 1990s, as FAD fishing become very common in the east tropical Atlantic, the catch started increasing, and is now at nearly 20 000 tonnes. As these catches consist of very small fish, the number of fish caught is very significant. Since 1996, area-time regulation of FAD fishing has been introduced, and the increase in the catches of small bigeye appears to have halted.

2.5.3 Catches by country

The catches by the ten main bigeye fishing fleets are shown in Figure 2.16. **Japan** has been the largest producer; its catches rose until the mid-1990s, but have since been declining. A **Spanish** baitboat fishery existed for a long time near the Canary Islands, and in the 1990s the catch by purse seiners increased rapidly, due to the adoption of FADs. **French** purse seiners had always caught a certain quantity of bigeye, and this increased in the 1990s with FAD fishing. **Taiwanese** and **IUU** longliners started targeting bigeye in the 1990s and their catches have increased rapidly in the last ten years. **Portuguese** catches are made mostly by baitboats near islands.

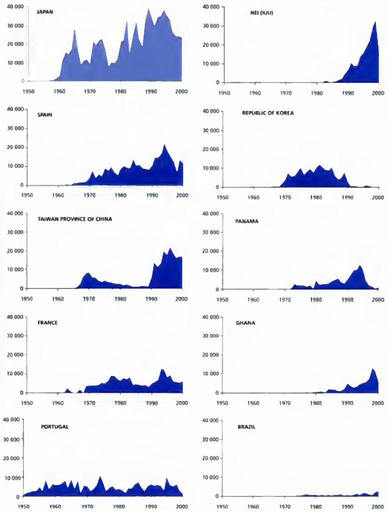
2.6 SKIPJACK TUNA

2.6.1 General overview

Skipjack are distributed widely in the tropical and subtropical waters of the Atlantic Ocean. In general, they school near the surface, and are taken almost exclusively by

FIGURE 2.16

Bigeye catches (tonnes) in the Atlantic Ocean, by the ten main fishing fleets



surface gears (baitboat and purse seine). The skipjack fisheries started in the late 1950s and developed rapidly. Figure 2.17 shows the total Atlantic catch and those of the east and west Atlantic. The total catch increased until the beginning of the 1980s, except for 1974 and 1975, then decreased until 1990 due to the reduction of purse-seine effort. In the early 1990s the catch jumped up to almost 200 000 tonnes with the return of purse seiners from the Indian to the Atlantic and with the commencement of FAD fishing. In last few years the catch has levelled off.

FIGURE 2.17
Catches of skipjack in the Atlantic, total and by stock

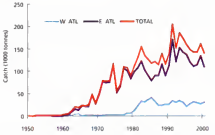


FIGURE 2.18
Catches of skipjack in the East Atlantic, by fishing gear

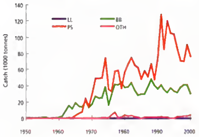
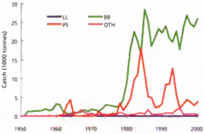


FIGURE 2.19
Catches of skipjack in the West Atlantic, by fishing gear



Two stocks, east and west, are assumed in the Atlantic, based on geographical distribution of catches and tagging data. The catch level in the east has always been much higher than that of the west. Catches of the east stock increased rapidly from the early 1960s until the early 1980s and stabilized at the level of 60 000 tonnes; they started increasing again in the 1990s. The west stock catches started only in the early 1980s, and have been stable at about 20 000 to 30 000 tonnes until now.

One characteristic of the skipjack fishery is that it is multi-species fishery. Most of the fleet targets yellowfin tuna, and the effort for skipjack is secondary. Also the availability of skipjack to the fisheries varies from year to year, leading to large inter-annual fluctuations in the catch.

2.6.2 Catch by gears

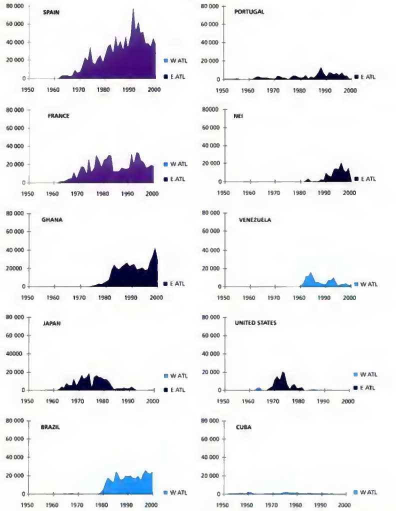
Figures 2.18 and 2.19 show Atlantic skipjack catches by major fishing gears for east and west stocks, respectively. The catches of skipjack during 1950–2000 by the ten main fishing fleets are shown in Figure 2.20.

Baitboat fishery

East: The baitboat fishery started with Spanish and French boats in the Gulf of Guinea in the early 1960s. However, this was soon replaced by the purse-seine fishery. Japanese baitboats based in Ghana, started operations in the early 1960s, followed by Korean and Panamanian baitboats; the fishery is still active with Ghanaian boats. Catches stayed at about 30 000–50 000 tonnes. Unlike the purse-seine fishery in the same area, the main target is skipjack rather than yellowfin.

West: The baitboat fishery off southern Brazil was started by Japanese boats that moved from Ghana in the mid-1970s, and in the late 1970s Brazilian baitboats started fishing off central Brazil. Both these fisheries, which target skipjack, continue at present, and their total catch is about 20 000 to 30 000 tonnes.

FIGURE 2.20
Skipjack catches (tonnes) by the ten main fishing fleets in the Atlantic, by region



Purse-seine fishery

East: The purse-seine fishery, started by Spain and France in the Gulf of Guinea a couple of years after their baitboats started fishing in that same area, developed very quickly and replaced the baitboat fishery. The catch reached the first peak of 70 000–80 000 tonnes in the early 1970s, then stabilized until the early 1990s when FAD fishing started. With the development of FAD fishing, the purse-seine catch started increasing again, reaching a level of 120 000–140 000 tonnes. In the last few years, it has fallen slightly, due partly to the regulation of FAD fishing in the tropical eastern Atlantic. Purse seiners target mainly yellowfin.

West: The purse-seine fishery in the west has been mostly opportunistic. It was started in the late 1970s by boats that usually fished in the eastern Pacific, and fishing in this area is generally done by seiners on their way to and from the Pacific. The catch has never exceeded 20 000 tonnes.

2.6.3 Catches by country

The largest skipjack producer in the Atlantic is **Spain**, with baitboats in the 1960s and purse seiners since 1970. The fishing grounds are mostly in the Gulf of Guinea, which expanded over time, mostly towards the south and west. The catch peaked in the early 1990s. While Spanish seiners target skipjack together with yellowfin, **French** seiners target mostly yellowfin, and thus the skipjack catch is less. **Ghana** is growing in importance as a skipjack producer, mostly with former **Japanese** and **Korean** baitboats that were based in Tema in the 1960s and 1970s, and more recently with seiners. Many of the **Japanese** baitboats formerly in Ghana moved to Brazil and started the **Brazilian** skipjack fishery. Recent **NEI** catch is by FOC purse seiners, in the Gulf of Guinea. **United States** seiners also fished in the Gulf of Guinea during the 1970s, but left the area in the early 1980s.

2.7 YELLOWFIN TUNA

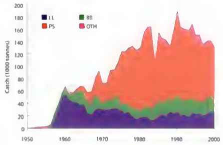
2.7.1 General overview

The total catch of yellowfin tuna in the Atlantic, accumulative by fishing gear, is shown in Figure 2.21.

Yellowfin are distributed across the Atlantic between 45°N and 40°S. The spawning area is in tropical and subtropical waters. Juveniles are found near the surface and relatively near the coast, particularly in eastern tropical waters, schooling with juveniles of other tropical tunas such as skipjack and bigeye. As they grow, the fish move offshore and towards the west Atlantic but, unlike bigeye, their habitat is still relatively near the surface. The juveniles are caught by surface gears, and adults by both surface gears and longlines. It is considered that only one stock exists in the entire Atlantic.

The fishery started with baitboats and longlines in the late 1950s, and catches reached 60 000 to 75 000 tonnes. Purse seiners started fishing in the mid 1960s, and the catch rose to over 150 000 tonnes by the early 1980s; it then declined somewhat, but reached another peak of 210 000 tonnes in the early 1990s. The catches by purse seiners have dominated the total since the early 1970s.

FIGURE 2.21
Catches of yellowfin in the Atlantic, cumulative, by fishing gear



2.7.2 Catch by gear

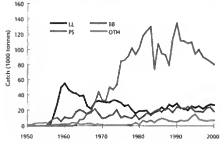
The Atlantic yellowfin catch by fishing gears is shown in Figure 2.22, and the catches during 1950–2000 by the ten main fishing fleets are shown in Figure 2.23.

Baitboat fishery

The baitboat fishery for yellowfin was started by Spain and France in the eastern tropical Atlantic in the 1950s. This type of fishing still continues in Senegal and Angola, although its scale has been reduced. Japanese baitboats started operating out of Ghana, in the early 1960s, and were followed by the Korean and Panamanian fleets. They have now been replaced by Ghanaian-flag baitboats, which are still operating. This fishery is of a multi-species nature and catches mostly skipjack, but also fishes for yellowfin and bigeye. The yellowfin catch in the East Atlantic has been stable at about 20 000 tonnes.

FIGURE 2.22

Catches of yellowfin in the Atlantic, by fishing gear



Longline fishery

The large-scale longline fishery was started in the late 1950s by Japan, and expanded very rapidly in tropical waters from west to east during the 1960s. As the Republic of Korea and Taiwan Province of China started longline fishing, the total catch increased very rapidly to nearly 60 000 tonnes. These catches were generally frozen and sold for canning, but in the 1970s the Japanese fleet changed its target to bigeye for the *sashimi* market, and the Taiwanese fleet changed its target from yellowfin to albacore. As a result, the Republic of Korea, Cuba, Venezuela, Brazil and FOC-IUU fleets became the major producers of longline yellowfin catches. Now even yellowfin are frozen with super-cold freezers and sold in the *sashimi* market, although their value is less than that of bigeye. Recent longline catches have been between 20 000 and 30 000 tonnes.

Purse-seine fishery

The purse-seine fishery was started by Spain and France in the same fishing grounds as, and soon after, the baitboat fishery in the Gulf of Guinea. This fishery developed very quickly and replaced their baitboat fishery. The catch reached its first peak of 130 000 tonnes in the early 1970s. In the early 1980s, the catch rate of yellowfin in the eastern tropical Atlantic declined, while fishing grounds with very high catch rates were developed in the western Indian Ocean. As a result, many French and Spanish purse seiners moved from the Atlantic to the Indian Ocean, and the yellowfin catch was reduced to 70 000–100 000 tonnes.

When some of these purse seiners returned to the Atlantic in the late 1980s, the catch started increasing again and attained the maximum of over 130 000 tonnes in 1990. When FAD fishing started, the catch stabilized at a high level until mid-1995. FAD fishing increased the catch of small fish, and the purse-seine catch of large yellowfin in offshore waters declined. In general the catch in last several years has been decreasing, due partly to the shift from large fish to smaller fish and partly to the regulations on FAD fishing in the eastern tropical Atlantic.

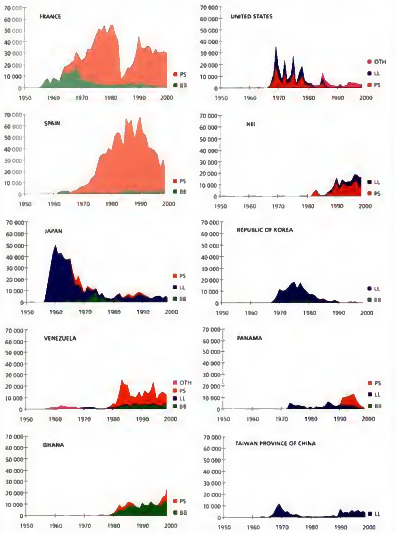
The purse-seine fishery in the western Atlantic is opportunistic. It was started in the late 1970s by Venezuelan purse seiners that fished mostly in the eastern Pacific. The vessels that fish in this area are generally from the Pacific, and the catch has never exceeded 20 000 tonnes.

2.7.3 Catches by country

Purse-seiners of **France**, **Spain** and **NEI** fleets are by far the largest producers of yellowfin in the Atlantic. Their catch trends reflect the development of the purse-seine fleet in the eastern tropical Atlantic. Until the end of the 1960s the largest catches of yellowfin were made by **Japanese** longliners. The **Venezuelan** catch since the early 1980s has been mostly by longliners near coasts. The **United States** catch in the 1960s was by purse seiners in the east Atlantic, but more recently from near the coast of the

FIGURE 2.23

Yellowfin catches (tonnes) by the ten main fishing fleets in the Atlantic Ocean, by fishing gear



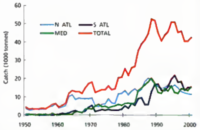
United States. **Ghanaian** catches, which started in the late 1970s, are made mostly by baitboats, but more recently also by seiners. **Korean** and **Panamanian** catches are by baitboats and longliners.

2.8 SWORDFISH

2.8.1 General overview

Swordfish are widely distributed in the Atlantic Ocean between 50°N and 40°S and in the Mediterranean Sea. Swordfish in the Mediterranean and North Atlantic are considered as two separate stocks, as there are two spawning areas, one in the tropical waters of the Atlantic and another in the Mediterranean. In the Atlantic it is considered that there are two further stocks, one in the north and one in the south, tentatively divided at 5°N. Catches, total and by stock, are shown in Figure 2.24.

FIGURE 2.24
Catches of swordfish in the Atlantic, total and by stock

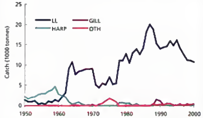


During the 1950s, the swordfish catch was all from the North Atlantic, and remained at a low level. It increased moderately from the 1960s until the early 1980s, and very rapidly during the 1980s. In the 1990s it levelled off between 45 000 and 55 000 tonnes.

North: The North Atlantic catch of about 5 000 to 9 000 tonnes dominated the total during the 1960s and 1970s. From the mid-1970s it increased, to 20 000 tonnes in 1987, but decreased thereafter, mostly due to catch regulations.

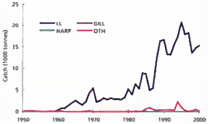
South: The South Atlantic catch was almost nil until the 1970s, and in the 1970s and early 1980s was mostly by-catch in the tuna longline fisheries and much less than the North Atlantic catch. However, with the commencement of longline operations targeting swordfish at the end of 1980s, it increased very rapidly to 15 000 to 20 000 tonnes, and in the 1990s was at about the same level as the North Atlantic catch.

FIGURE 2.25
Catches of swordfish in the North Atlantic, by fishing gear



Mediterranean: Mediterranean catch statistics are not as accurate as those for the Atlantic Ocean, and are possibly under-estimated. Catches were low until the mid-1980s, at about 5 000 tonnes, but increased very rapidly in the late 1980s. In the 1990s they stabilized at around 15 000 tonnes, and in the 1990s were at about the same level as the North and South Atlantic catches.

FIGURE 2.26
Catches of swordfish in the South Atlantic, by fishing gear

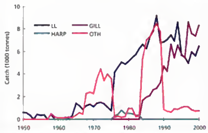


2.8.2 Catch by fishing gears

The swordfish catch from the North and South Atlantic and Mediterranean, by fishing gears, is shown in Figures 2.25, 2.26 and 2.27, respectively. Swordfish are harvested almost exclusively by longlines; the only significant exceptions are harpooning and gillnetting.

FIGURE 2.27

Catches of swordfish in the Mediterranean, by fishing gear



Longline fishery

Longlines that target tunas are generally set in the daytime at depth and catch swordfish as by-catch, whereas those targeting swordfish are set at night and at relatively shallow depths. The structures and materials of the longlines are also different.

North: In the late 1950s and early 1960s, longline fisheries targeting swordfish were developed very quickly by Canada, the United States and Spain, while large-scale multi-species longlining by oriental fleets (Japan, and later the Republic of Korea and Taiwan Province of China) started catching swordfish as by-catch. In the early 1970s, due to restrictions on mercury content in fish, the swordfish fisheries, particularly those of Canada and the United States, were reduced to a very low level, if not nil. The fishery resumed in the mid-1970s.

The annual catch was mostly less than 10 000 tonnes until the beginning of the 1980s. During the 1980s it increased very rapidly, corresponding to the expansion of the market, and reached 20 000 tonnes. However, in the early 1990s the ICCAT catch quota regulation was introduced, and since then the catch has been controlled at between 12 000 and 15 000 tonnes.

South: The South Atlantic swordfish catch, by fishing gears, is shown in Figure 2.26. Initially fisheries targeting swordfish existed exclusively in the North Atlantic, but since the early 1960s the southern stock has been harvested at the level of 3 000 to 5 000 tonnes by longline vessels, mostly Japanese and Taiwanese, while targeting other species. In the late 1980s, the Spanish, and to a lesser extent the Portuguese and US, longline fisheries for swordfish in the North expanded their fishing ground to the south, and this was accelerated in the early 1990s when ICCAT set a quota for northern swordfish. At the same time, Brazilian longliners also started targeting swordfish. Since the late 1990s, swordfish in the South Atlantic has also been under ICCAT management measures, with a TAC and quota system, and the catch has been reduced to the level of 15 000 tonnes.

Mediterranean: The Mediterranean swordfish catch, by fishing gears, is shown in Figure 2.27. Longlines have become important only since 1975. The catch increased rapidly to 9 000 tonnes by 1988, but has since declined to about 6 000 tonnes.

Gillnet fishery

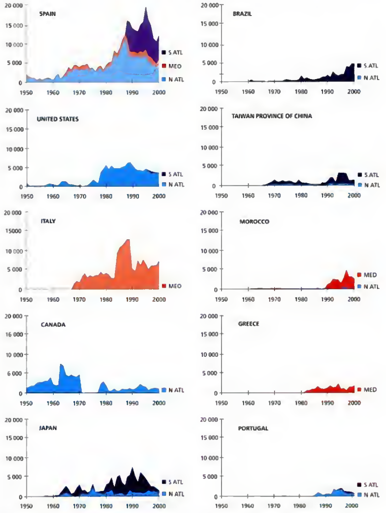
The only notable gillnet catches in the Atlantic were by Taiwanese vessels from the late 1970s to 1982. However, this fishing method has been widely practised in the Mediterranean, and it is likely that the unclassified catches of about 4 000 tonnes reported in the 1960s and 1970s were by gillnet. Reported gillnet catches started only in 1983, but increased very rapidly and exceeded the longline catch by the mid-1990s. The current gillnet catch in the Mediterranean is about 8 000 tonnes.

Harpoon fishery

In the 1950s, swordfish were mostly harvested by harpoon in the northwestern Atlantic. However, in the late 1950s the catch of this fishery declined, and by the 1980s was at a minimal level. In the Mediterranean, harpoons have been widely used to harvest swordfish, but the catches have been very minor and/or are reported as by other or unclassified gears.

FIGURE 2.28

Swordfish catches (tonnes) by the ten main fishing fleets in the Atlantic Ocean, by stock



2.8.3 Catches by country

The catch by the ten main swordfish-catching countries is shown in Figure 2.28.

The **Spanish** longline fishery is by far the largest producer of swordfish in the Atlantic. It became significant in the 1960s, and the catch has increased rapidly since the beginning of the 1980s; it levelled off in the 1990s, due mostly to ICCAT quota regulations. The **United States** started significant longline fishing for swordfish in the 1970s, after the mercury restriction was eased. **Italian** catches are all from the Mediterranean, and are made by various gears, including gillnet, harpoons and longlines; they have been quite high in recent years. **Canada** used to have the greatest catches of swordfish, but after the mercury restriction in the 1970s its catches never returned to their previous level. The **Japanese** and **Taiwanese** fleets catch swordfish as by-catch, particularly when targeting bigeye, and hence catches of swordfish have increased in recent years together with the increase in bigeye catches. **Morocco** and **Brazil** started fisheries targeting swordfish in recent years.

3. Development of the Indian Ocean tuna fisheries

3.1 DATA SOURCES AND PREPARATION

The data source used in this study is the IOTC fishery statistics issued in January 2003, which cover the 1950-2000 period. It should be noted that there are no bluefin tuna in the Indian Ocean. Therefore the "major tunas" in this chapter refers to only four species of tunas (albacore, bigeye, skipjack and yellowfin). Swordfish are also reviewed in the section on species. However, the figures in Section 3.2 swordfish are not included.

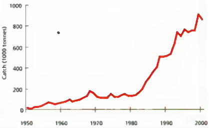
3.2 GENERAL OVERVIEW

3.2.1 Total catch

Figure 3.1 shows the combined reported catches of the four major tuna species in the Indian Ocean, 1950–2000. The catch increased gradually to about 200 000 tonnes in the early 1980s, and thereafter rapidly to 700 000 to 900 000 tonnes by 1999. The rapid increase is mostly due to the introduction by France and Spain in the early 1980s of purse-seine fisheries targeting skipjack and yellowfin tunas.

FIGURE 3.1

Catches of major tuna species in the Indian Ocean

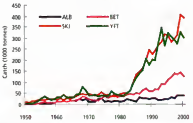


3.2.2 Catch by species

Figure 3.2 shows the catches in the Indian Ocean of the major species of tunas, and Figure 3.3 shows the species composition of the catches. The catch trends of each species are discussed in the following sections, and only their relative importance is described in this section. Until the early 1980s, the amounts of tuna caught were relatively small, less than 50 000 tonnes for each species. The combined catch of skipjack and yellowfin increased rapidly up to the 300 000 to 400 000 tonnes level in the 1990s, largely due to the introduction of purse seines in the western Indian Ocean by France and Spain. These two species have each accounted for more than 40 percent of the total catch during most of the period covered by this study. The catch of bigeye has also increased, to around 150 000 tonnes, because of increased targeting of tunas for the

FIGURE 3.2

Catches of major tuna species in the Indian Ocean, by species



sashimi market by longline vessels and the use of FADs in the surface fishery. Although the catch of albacore increased gradually in the past five decades, its relative importance decreased rapidly.

FIGURE 3.3
Species composition of major tuna species of the Indian Ocean catches

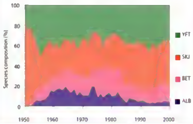
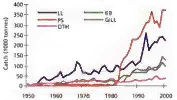


FIGURE 3.4
Catches of major tuna species in the Indian Ocean, by fishing gear



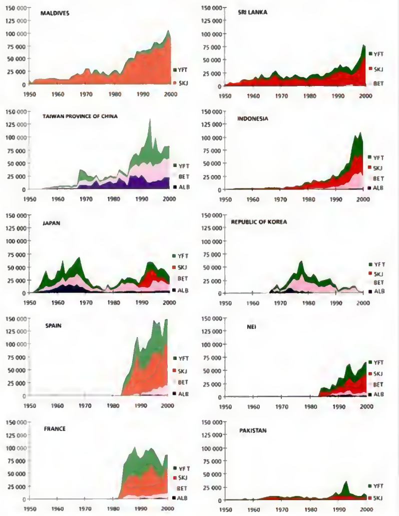
3.2.3 Catch by fishing gears

Compared with other oceans, longlines contribute to the catch much more significantly (Figure 3.4). The Japanese, Taiwanese and Korean longline fishery and small artisanal fisheries (baitboat, troll and gillnet) of coastal nations (Maldives, Sri Lanka and some others) were the major fisheries in the Indian Ocean until the early 1980s. Predominant were the Japanese longline catches, which fluctuated around 20 000 tonnes. The longline catch then started increasing, due to the increase in the number of longline fishing vessels of Taiwan Province of China, the Republic of Korea, and Indonesia, and reached almost 260 000 tonnes by 1993. However, the development of the purse-seine fishery was even faster, and its catches have exceeded the longline catch since the early 1980s. The catches in the purse-seine fishery targeting skipjack and yellowfin, introduced in the western Indian Ocean by France and Spain in the mid-1980s, together exceeded 350 000 tonnes in 1995. Baitboat catches have increased gradually since the mid-1980s, due to the increase of the catch by the Maldives.

3.2.4 Catches by country

The combined catches of the major tunas from the Indian Ocean during 1950–2000 by the ten main fishing fleets are shown in Figure 3.5. Maldives historically caught skipjack with baitboats, and the catch level increased from the 1980s. The catch by Taiwan Province of China was mostly made by longliners; and consisted of albacore, yellowfin and bigeye in almost equal amounts. Until the 1960s the Japanese catch was mostly for canning. After low catches in the 1970s the Japanese longliners started targeting tunas for the *sashimi* market, mostly bigeye (the major target of Japanese longliners in the Indian Ocean is southern bluefin tuna, discussed in Chapter 5). Spain and France introduced an industrial purse-seine fishery targeting yellowfin and skipjack in the western Indian Ocean in the 1980s, and the catch increased rapidly since then. Sri Lanka catches mainly yellowfin and skipjack in artisanal fisheries, and catches have exceeded 80 000 tonnes in the last two years. Indonesia developed a longline fishery for bigeye in the late 1980s, and its combined catch of all species has exceeded 60 000 tonnes in 1997 and 1998. The Republic of Korea is also a longline fishing country; it started fishing in the Indian Ocean in the late 1960s, and made its peak catches between the late 1970s and 1980s, since when its catch have decreased to around 5 000 tonnes in 1998. NEI includes mostly purse seiners and some longliners, all of flag of convenience; their catches occur only since the mid-1980s. Pakistan catches yellowfin and skipjack tunas by artisanal fisheries.

FIGURE 3.5
Indian Ocean catches (tonnes) of major tuna species by the ten main fishing fleets



3.3 ALBACORE

3.3.1 General overview

Albacore inhabit pelagic waters in the temperate area of the Indian Ocean, and are mainly caught by the longline fishery. The catch of albacore in the Indian Ocean is shown in Figure 3.6. Starting in the 1950s, it increased gradually from less than 5 000 tonnes to levels of 10 000 to 30 000 tonnes during the 1960s to 1980s. It further

FIGURE 3.6
Catches of albacore in the Indian Ocean

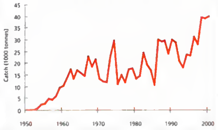
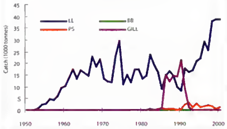


FIGURE 3.7
Catches of albacore in the Indian Ocean, by fishing gear



increased in the 1990s, up to its highest level of 40 000 tonnes in 1998–89.

3.3.2 Catch by fishing gears

Figure 3.7 shows the Indian Ocean albacore catches by major fishing gears. The main fisheries catching albacore are the large-scale longline and driftnet fisheries. Since the end of 1992 the driftnet fishery has been under the moratorium imposed by the resolution of the United Nations, and at present the longline fishery is the only major fishery catching albacore.

Longline fishery

In the early 1950s, Japanese longliners entered the Indian Ocean and started fishing in tropical and temperate waters, targeting yellowfin and bigeye; albacore was a subsidiary target. After the introduction of super-cold freezers in the late 1960s, the fleet shifted its target from those tunas to southern bluefin in the Indian Ocean, which inhabit the cold waters around 40°S. Due to this change in fishing pattern, the Japanese albacore catch decreased.

Taiwan Province of China started longline fishing in the Indian Ocean in the late 1960s, targeting primarily fish for canning. The catch increased to 20 000 tonnes in the early 1980s. Driftnet fisheries also started in the 1980s, and the longline catch decreased to between 5 000 and 13 000 tonnes. However, after the moratorium on the driftnet fishery in 1992, the longline catches increased again to over 20 000 tonnes.

The Republic of Korea started longline fishing in the Indian Ocean in the late 1960s. The albacore catch peaked at 9 000 tonnes in 1974, then it started decreasing until it reached the level of less than 100 tonnes in the late 1980s and early 1990s. It has remained at that level until the present.

Indonesia started a longline fishery in the 1990s, targeting mainly southern bluefin, but also catching albacore. At present, Taiwan Province of China and Indonesia are the two major longline countries catching albacore in the Indian Ocean.

Purse-seine fishery

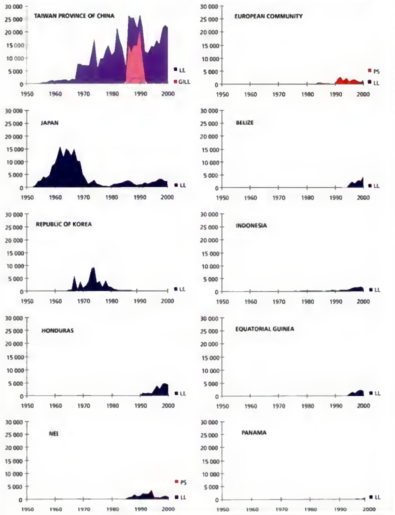
Spain and France started purse-seine fishing in 1984 in the western Indian Ocean, targeting yellowfin and skipjack. Since albacore are by-catches, the catch level has fluctuated, but is relatively low. Other countries with purse-seine fisheries include the former Soviet Union, Japan and the Islamic Republic of Iran.

Drift gillnet fishery

The other major fishery catching albacore in the Indian Ocean was the Taiwanese drift gillnet fishery. This fishery rapidly expanded in the late 1980s, and catches

FIGURE 3.8

Albacore catches (tonnes) by the ten main fishing fleets in the Indian Ocean, by fishing gear



reached 15 000 to 20 000 tonnes, but fell sharply after the fishery came under the UN moratorium in 1992.

3.3.3 Catches by country

Four longline fishing fleets (Taiwan Province of China, Japan, the Republic of Korea and Indonesia) and two purse-seine fishing fleets (Spain and France) play major roles in albacore fishing in the Indian Ocean (Figure 3.8). **Taiwan Province of China** started its longline fishery in 1966, and until recently was the only longline fleet targeting albacore; catches of albacore, by both longline and drift gillnet fisheries, increased gradually to 26 000 tonnes in the late 1980s, then dropped to 12 000 tonnes in 1992, but increased again to 22 000 tonnes in 1999. **Japanese** tuna longliners entered the Indian Ocean in 1952, and their albacore catch increased to over 15 000 tonnes in the late 1960s, then dropped to 1 100 tonnes in 1972, and has since fluctuated between 300 and 3 000 tonnes. The **Republic of Korea** began longline fishing in 1965; its albacore catch exceeded 5 000 tonnes in 1967 and over 9 000 tonnes in 1974, then decreased to less than 1 000 tonnes after 1981 and to less than 100 tonnes in some years of the 1990s, as the Korean longline fleet started leaving the Indian Ocean. The **Indonesian** longline fishery started catching albacore in 1982. Catches rose to 1 800 tonnes in 1987 and 3 700 tonnes in 1990, then fell to between 500 and 1 700 tonnes in the 1990s.

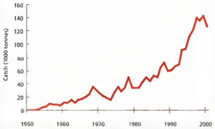
France and Spain started to catch albacore as by-catch in their tropical purse-seine fishery in the Indian Ocean in 1984. Their catches of albacore were relatively low, under 4 000 tonnes. FOC (IUU) longliners have operated in the Indian Ocean only since the mid-1990s.

3.4 BIGEYE TUNA

3.4.1 General overview

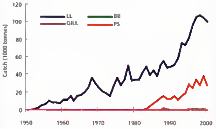
Bigeye tuna inhabit tropical and temperate waters, and generally stay in deeper and colder waters than yellowfin. Bigeye are caught mainly by longlines, but by-catches of bigeye in the purse-seine fishery have also been increasing since seiners started fishing for yellowfin and skipjack associated with FADs.

FIGURE 3.9
Catches of bigeye in the Indian Ocean



The total Indian Ocean bigeye catch is given in Figure 3.9. Catches started in the early 1950s and increased gradually to over 20 000 tonnes in the late 1960s, 40 000 tonnes in the 1980s, and then rapidly to 140 000 tonnes in 1998, due to the increased catches by both the longline and purse-seine fisheries. The longline catch rose gradually to 100 000 tonnes between 1952 and 1998; the purse-seine catch started to increase much later, in the early 1980s, and reached 40 000 tonnes in 1999.

FIGURE 3.10
Catches of bigeye in the Indian Ocean, by fishing gear



3.4.2 Catch by fishing gears

The Indian Ocean bigeye catch by fishing gears is given in Figure 3.10.

Large-scale longline fishery

The longline catch made up over 70 percent of the Indian Ocean bigeye catches throughout the period covered by this study. Japan started its longline fishery in the Indian Ocean in 1952, targeting yellowfin and bigeye for the canning industry. The Republic of Korea and Taiwan Province of China entered the longline fishery in the Indian Ocean in the late 1960s. In the 1970s, when

when many of these longliners shifted their target to fish for the sashimi market, the catch stabilized between 40 000 and 60 000 tonnes. Indonesia started longline fishing in the Indian Ocean in the 1980s. Also, many longliners flying "flags of convenience" increased bigeye catches in the late 1990s. As a consequence, in the 1990s the total bigeye catch started increasing again sharply, to over 100 000 tonnes. There are wide annual fluctuations related to fishing conditions in other oceans and market conditions. For example, when Atlantic bluefin and bigeye and southern bluefin in the Indian Ocean fetch higher prices than Indian Ocean bigeye, and if their catch rates are not too low, longliners prefer to target those fish.

Purse-seine fishery

Bigeye tuna are caught as by-catch in the purse-seine fishery which targets yellowfin and skipjack. French and Spanish purse-seine fleets which had been fishing in the tropical eastern Atlantic entered the western Indian Ocean in the early 1980s. With high fishing rates, this fishery developed very quickly, as did the bigeye by-catch. In the mid-1990s, purse-seine fishing with FADs developed very widely in the Indian Ocean. As more small fish gather around FADs compared with schooling fish, the by-catch of small bigeye in the fishery increased rapidly, to nearly 40 000 tonnes. Those are mostly juvenile fish, while those caught by longlines are mostly adult fish.

Other than France and Spain, Japan started a purse-seine fishery in the Indian Ocean in 1978, and, less importantly, Mauritius has conducted purse-seine fishing since 1980. Liberia, Belize and Seychelles reported purse-seine catches of bigeye exceeding 1 000 tonnes in several years. Purse seiners with the flags of these countries appear to be operating under "flags of convenience", with owners in major purse-seine fishing nations.

Other fisheries

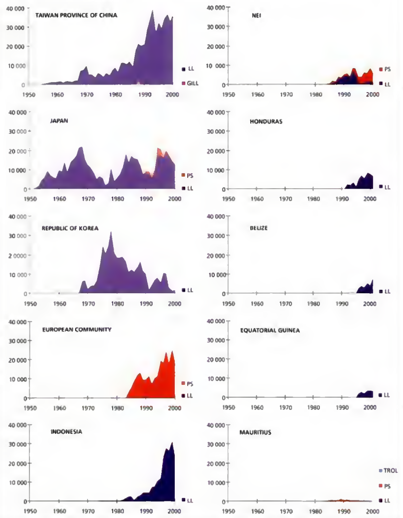
Taiwan Province of China harvested nearly 2 000 tonnes of bigeye in 1988 in so-called "other" fisheries, probably a driftnet fishery. Another "other" fishery has been conducted by Sri Lanka, most likely coastal artisanal fisheries. The baitboat fishery in the Maldives has caught around 600 tonnes in recent years.

3.4.3 Catches by country

The bigeye catches from the Indian Ocean during 1950-2000 by the ten main fishing fleets are shown in Figure 3.11, by fishing gears. Three longline fishing countries (Taiwan Province of China, Japan and the Republic of Korea) contributed almost all the bigeye yield until the mid-1980s. The Indonesian longline catch became significant in the 1990s, while the French and Spanish purse-seine catch became important in the mid-1980s.

Japan started its longline fishery in the Indian Ocean in 1952, and its catch increased to over 20 000 tonnes in 1967 and 1968. Initially the longliners were equipped with freezers of –20 °C capacity, and the catch was mostly for canning; therefore, albacore and yellowfin were the preferred species. In the late 1960s the Japanese fleet changed its strategy to catch fish for the domestic sashimi market, and was equipped with super-cold freezers of –40 ° to –50 °C. The catch of bigeye then decreased sharply until the late 1970s, as the fleet preferred to fish in other oceans for bluefin and southern bluefin. However, in the 1980s Japanese vessels returned to the Indian Ocean, and the catch rose again to 20 000 tonnes in the mid-1980s. **Taiwan Province of China** started catching bigeye in 1967; its catches started increasing in the late 1970s, as it followed the Japanese fleet in fishing for the sashimi market, and reached about 40 000 tonnes in 1993 and 1998. The **Republic of Korea** started its longline fishery in the Indian Ocean in 1965; catches of bigeye increased rapidly, to 33 000 tonnes in 1978, then gradually decreased to less than 10 000 tonnes in the early 1990s, as the fleet left the Indian Ocean.

FIGURE 3.11
Bigeye catches (tonnes) by the ten main fishing fleets in the Indian Ocean, by fishing gear



The Spain and France started a purse-seine fishery in the early 1980s, when the catch rate of tropical tunas declined drastically in the eastern Atlantic. However, a significant increase in bigeye catches occurred only when these seiners started fishing with FADs (see Section 3.4.2). NEI (i.e. Honduras, Belize and Equatorial Guinea flags of convenience) started fishing only in the 1990s, but their catches are increasing rapidly.

3.5 SKIPJACK TUNA

3.5.1 General overview

Skipjack is one of the most abundant pelagic tuna species, inhabiting tropical waters. Skipjack are caught by variety of fisheries – purse seine, baitboat and many kinds of small-scale coastal fisheries– but by far the majority of the catch is made by purse-seine and baitboat fisheries, and is supplied to the canning industry.

The total skipjack catch in the Indian Ocean is shown in Figure 3.12. Catches stayed at a relatively low level until the early 1980s, but thereafter increased rapidly, to almost 300 000 tonnes in the early 1990s and over 400 000 tonnes by the end of the 1990s. This sudden increase in catch is due to the development of the purse-seine fishery. Catches by baitboats and other fisheries also increased in the 1990s, but not as rapidly as in the purse-seine fishery.

3.5.2 Catch by fishing gears

Figure 3.13 shows skipjack catches by fishing gears. Until the early 1980s, the baitboat catch was the most important and stable as a single gear category. It started increasing in the mid-1980s, but the purse-seine catch, started in 1981, increased more rapidly, exceeding the baitboat catch and accounting for over half of the total skipjack catches since 1990. The gillnet catch has also increased in recent years, getting close to that of baitboats.

Longline fishery

The longline fishery targets large tunas, hence the skipjack by-catch by longliners (both large-scale and coastal) is negligible.

Purse-seine fishery

France and Spain developed the purse-seine fishery in the western Indian Ocean in the early 1980s. Since then, the skipjack catch has kept increasing, with a slowdown in the mid-1990s. Recently the most important part of the skipjack catch in the Indian Ocean has been made by the purse-seine fishery using FADs. As these purse seiners also fish in the eastern Atlantic, the catches from both oceans are interdependent, depending on the catch rates in both oceans and the prices paid in various markets.

FIGURE 3.12

Catches of skipjack in the Indian Ocean

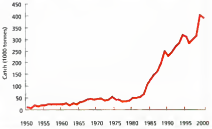
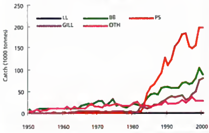


FIGURE 3.13

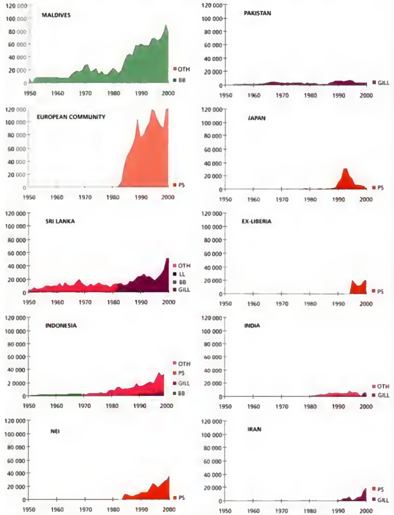
Catches of skipjack in the Indian Ocean, by fishing gear



Baitboat fishery

The baitboat fishery is another important fishery catching skipjack; it is dominated by the Maldives fishery, which now accounts for almost all the baitboat catches in the Indian Ocean. Baitboat fishing is an old traditional method, and catches showed increasing trends even in the 1950s to 1970s, but never exceeded 40 000 tonnes. Since the mid-1980s, catches have increased rapidly, due to the fast development of the Maldives fishery. This fishing method is very much limited by the

FIGURE 3.14
Skipjack catches (tonnes) by the ten main fishing fleets in the Indian Ocean, by fishing gear



availability of bait, and that is possibly the reason that only the Maldives fishery has developed.

Other fisheries
Skipjack tuna is caught by other fisheries by a variety of countries. Among these, the Sri Lankan gillnet fishery is the most important, and has been increasing rapidly in recent years.

3.5.3 Catches by country

The skipjack catches from the Indian Ocean during 1950–2000 by the ten main skipjack fishing fleets are shown in Figure 3.14. The largest cumulative skipjack catch in this period was made by **Maldives**, which has reported catches, almost exclusively by baitboats, since the beginning of the fishery statistics series in 1950. Catches stayed around 10 000 tonnes until the mid-1960s, then increased to 30 000 tonnes by the 1980s and 90 000 tonnes in 1999 and 2000.

Currently, the largest skipjack producers are the **French** and **Spanish** purse-seine fleet. The French fleet started the purse-seine fishery in 1981, and its catches reached almost 60 000 tonnes in 1994; however, it decreased to around 30 000 to 50 000 tonnes in the 1990s. The Spanish purse-seine fleet entered the Indian Ocean in 1984, a little later than French fleet; its catch rapidly increased to 77 000 tonnes by 1989, then decreased to 41 000 tonnes in 1991, but increased again to 76 000 tonnes in 1999 and 2000. Together, as the EC fleet, their catches of skipjack increased very rapidly during the 1980s to a peak of more than 100 000 tonnes in the 1990s. **NEI** and **Ex-Liberia** boats are seiners with flags of convenience, and the fishery is very similar to that of the EC seiners.

Sri Lanka has reported skipjack catches since 1950. The gear used to catch skipjack was listed as "unclassified" until the 1980s, and thereafter as gillnet; it is therefore suspected that all previous catches were also made by gillnets. Catches increased from 4 300 tonnes in 1950 to 10 000 tonnes in 1956, then stayed between 10 000 and 20 000 tonnes until 1988, after which they gradually increased to over 40 000 tonnes in 1999 and 2000.

Indonesia has reported skipjack catches since 1950. The major part of the catch was reported as caught by "other" gears, with small portions by purse-seine and gillnet fisheries. The catches gradually increased to several thousand tonnes by 1982 and to 27 000 tonnes in 1998.

Japan started an experimental purse-seine fishery in 1977. The skipjack catch stayed at a low level until 1989, then increased to more than 30 000 tonnes in 1992 and 1993. However, it decreased to less than 10 000 tonnes after 1996.

Pakistan and **India** have reported skipjack catches constantly, but at a low level. The Pakistani catch is mostly by gillnetting, while the Indian catch has been made by a variety of gears.

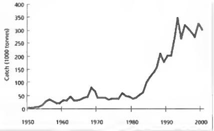
3.6 YELLOWFIN TUNA

3.6.1 General overview

Yellowfin tuna are widely distributed in tropical waters. They are caught by a variety of gears – purse seines, longline, and baitboats – and in many kinds of small-scale coastal fisheries.

Figure 3.15 shows the total yellowfin catch in the Indian Ocean. The catch stayed at a relatively low level, around 50 000 tonnes, until the early 1980s, then increased to over 350 000 tonnes in 1993. This sudden increase was due to the rapid development of purse-seine, gillnet and longline fisheries. Yellowfin caught by longliners in recent years are utilized for the *sashimi* market, while those caught by purse seine are for canning.

FIGURE 3.15
Catches of yellowfin in the Indian Ocean



3.6.2 Catch by fishing gears

Figure 3.16 shows Indian Ocean yellowfin catches by fishing gears.

Longline fishery
Japanese (since 1952), Korean (since 1966) and Taiwanese (since 1954) large-scale longliners were the major producers of yellowfin in the Indian Ocean until the early 1980s. The catch fluctuated widely between 20 000 and 60 000 tonnes. In the mid-1980s the longline catch started increasing, to a peak of 166 000 tonnes in 1993, the only year since 1983 in which the longline catch exceeded the purse-seine catch. The increase was mostly by Taiwan Province of China (large-scale longline), and partially by the increase of the Indonesian (small-scale longline) catch. After that peak it dropped to about 90 000 tonnes.

Purse-seine fishery
Recently the majority of the yellowfin catch has been made by the purse-seine fishery using FADs. The purse-seine fishery was developed by French and Spanish vessels, starting in 1981 and 1984, respectively, and catches increased very rapidly to 150 000 tonnes in 1995. In last five years the catch has fluctuated at a high level. Some other countries, such as Japan, Seychelles, the Russian Federation, Iran, Mauritius, and Liberia, reported purse-seine catches, but at a relatively low level.

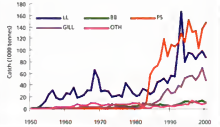
Other fisheries
Maldives has been fishing with baitboats since the early 1950s. The catches were less than or equal to 2 000 tonnes until 1972, then gradually increased and exceeded 12 000 tonnes in 1994. After that they stayed at around the same level. The gillnet fishery has also become important since the early 1980s: the catch, mostly by Sri Lanka and Iran, reached 68 000 tonnes in 1999.

3.6.3 Catches by country

The yellowfin catches from the Indian Ocean during 1950-2000 by the ten main fishing fleets are shown in Figure 3.17.

The **French** and **Spanish** purse-seine fleet caught yellowfin at a high level of over 80 000 tonnes since the mid-1980s. France started catching yellowfin in 1970, and began the purse-seine fishery in the Indian Ocean in 1981. The yellowfin catch remained at a low level before the start of the purse-seine fishery, then it increased dramatically to more than 10 000 tonnes in 1983, exceeded 40 000 tonnes in 1986, and reached almost 60 000 tonnes in 1988. After that it stayed around 40 000 tonnes, and then decreased to 20 000 tonnes in 1998. Spain started catching yellowfin in the Indian Ocean in 1981, and began a purse-seine fishery in 1984. The yellowfin catch by the Spanish fleet increased to 65 000 tonnes in 1995, then decreased to 37 000 tonnes in 1998. NEI (flag of convenience) and Iranian seiners show very similar trends, although at a level much lower than the EC catch.

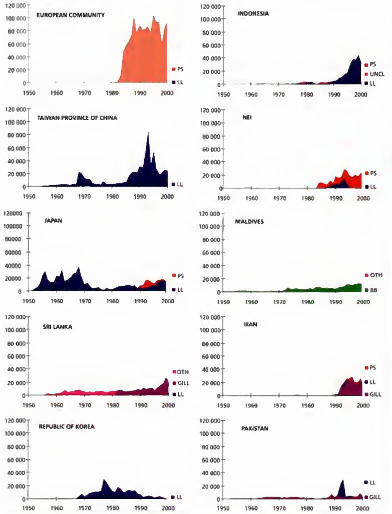
FIGURE 3.16
Catches of yellowfin in the Indian Ocean, by fishing gear



Taiwan Province of China started longline fishing in 1966 in the Indian Ocean. After the catch had increased to 22 000 tonnes in 1968, it decreased to less than 6 000 tonnes in 1973, and stayed at a low level of less than 10 000 tonnes until 1985. After that it increased again rapidly to reach 88 000 tonnes in 1993, but then dropped to the level of around 20 000 tonnes Japan started longline fishing in the Indian Ocean in 1952, targeting yellowfin and bigeye tunas. Japanese yellowfin catches increased to 30 000

FIGURE 3.17

Yellowfin catches (tonnes) by the ten main fishing fleets in the Indian Ocean, by fishing gear



tonnes in the mid-1950s, then fluctuated widely between 10 000 and 40 000 tonnes until 1970. After that, they decreased to less than 10 000 tonnes, because most of their longline effort was shifted to the southern bluefin tuna fishing grounds. However, they increased again to a level of over 10 000 tonnes since 1986. A limited purse-seine catch was also made in the 1990s. The **Republic of Korea** started longline fishing in the Indian Ocean in the late 1960s. The Korean catch increased in the late 1970s, exceeding 30 000 tonnes in 1978; after that it gradually decreased to less than 10 000 tonnes in the 1990s, as many Korean boats left the Indian Ocean.

The **Sri Lankan** and **Maldives** catches of yellowfin were stable during the 1960s to 1980s. Since the mid-1990s both catches have been increasing. The Sri Lanka catch was reported previously as by unclassified gears, and recently by gillnets, while the Maldives catch was by baitboats. Indonesia started longline fishing in 1982, mostly small-scale, and its catch has exceeded 10 000 tonnes since 1989. The catch level continued increasing, to over 40 000 tonnes in 1999.

FIGURE 3.18
Catches of swordfish in the Indian Ocean

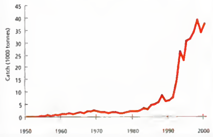
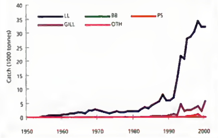


FIGURE 3.19
Catches of swordfish in the Indian Ocean, by fishing gear



3.7 SWORDFISH

3.7.1 General overview

Swordfish are widely distributed throughout the temperate, subtropical and tropical waters. Swordfish inhabit deeper layers in the daytime, and come up to shallower layers for feeding at night.

Figure 3.18 shows the total swordfish catch in the Indian Ocean during 1950–2000. It stayed at a relatively low level of 1 000 to 2 000 tonnes until the 1980s, then suddenly increased in the 1980s and particularly during the 1990s, reaching almost 40 000 tonnes in 1998. This increase is in response to the worldwide increase in price and demand for swordfish, and is also influenced by the catch limitations introduced by the various regulatory measures set for the Atlantic swordfish fisheries.

3.7.2 Catch by fishing gears

Swordfish catch by fishing gears is shown in Figure 3.19. Catches are almost exclusively by longline. In recent years, the gillnet catch has become significant, but is far less than that of longlines.

Longline fishery

In the Indian Ocean, most swordfish catch was made by longline fishery. Taiwan Province of China, and to a much less extent, Japan have played major historical role in the longline fisheries. The longline catch stayed at a lower level of 1 000 to 2 000 tonnes until early 1980s. It increased during 1980s and very rapidly in 1990s. The peak was in 1998 at 39 000 tonnes.

Other fisheries

The only other fishery with significant catches of swordfish is the coastal gillnet fishery in Sri Lanka. The reported gillnet fishery started in 1985, and catches stayed at a level of less than 1 000 tonnes until 1992, then suddenly increased to more than 4 000 tonnes in 1993. After that they have been stable at between 2 000 and 4 000 tonnes.

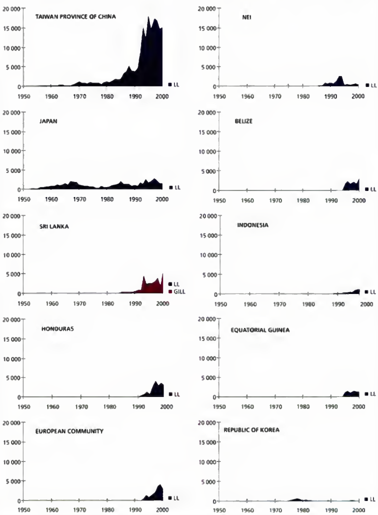


FIGURE 3.20
Swordfish catches (tonnes) by the ten main fishing fleets in the Indian Ocean, by fishing gear

3.7.3 Catches by country

The swordfish catches from the Indian Ocean during 1950-2000 by the ten main fishing fleets are shown in Figure 3.20. **Taiwan Province of China** reported the largest swordfish catch recently by its longline fleet. The first reported swordfish catch was in 1970, and it stayed at less than 3 000 tonnes until 1986, principally as by-catch in the yellowfin and albacore fishery. However, in the 1990s some longliners started targeting swordfish, and the catch rapidly increased to the record high of 18 000 tonnes in 1995, and has remained at a similar level until now. **Japan** has reported swordfish catches since the start of its longline fishery in the Indian Ocean in 1952. Its catch has fluctuated between 200 and 2 000 tonnes since then, all by-catch of the fisheries for yellowfin, southern bluefin or bigeye tunas.

Sri Lanka has reported swordfish catches since 1985, mostly by the gillnet fishery. Catches stayed at a relatively low level until 1992, but increased to 4 000 tonnes in 1993. Since then they have fluctuated between 2 000 and 4 000 tonnes.

Indonesia has been catching swordfish with longlines since 1974, but at a very low level. The catch gradually increased, and has exceeded 1 000 tonnes since 1997. Spain also started to catch swordfish in 1993 with longlines, most likely targeting swordfish. The catch increased to 2 000 tonnes in 1999.

Longliners from **Honduras**, **NEI**, **Belize** and **Equatorial Guinea** are all flying "flags of convenience", and are often IUU vessels. Their swordfish catches are generally by-catch, mostly in the 1990s. Other longline fishing countries include **Réunion** (France), **Australia** and **South Africa**, which have reported annual catches of swordfish exceeding 1 000 tonnes each in recent years.

4. Development of the Pacific tuna fisheries

4.1 DATA SOURCES AND PREPARATION

Various data sources for the Pacific were used in this study. The reason is that there are various regional fisheries bodies covering tuna statistics: IATTC for the eastern Pacific (east of 150°E), SPC for the central western Pacific (west of 150°E, but excluding northern albacore and Pacific bluefin tuna and southern bluefin tuna), and ISC (Pacific bluefin and northern albacore).

IATTC Annual Reports and the SPC Tuna Fisheries Yearbook 2000 were used for the eastern and central western Pacific tuna data. Data are available for 1952–2000 for most of the major species. However, catches by country are not available for all countries until 1980. Therefore, for the 1952–79 period, the FAO FISHSTAT-PLUS database was used for those countries for which data are missing. As FAO data have no breakdown by fishing gears, some assumptions have had to be made in some cases.

Japanese bigeye catch data before 1962 are also not available. The data for 1952–61 were taken from the FAO database, and hence the breakdown between eastern and western Pacific was not available. Also, those data were assigned to longline catches, though the gear breakdown was not available. For northern albacore and Pacific bluefin, the major source was the data presented at the ISC.

As many of the data were taken from different sources and the data aggregations (by fishing gear, country and area) are different between data sources, the annual sum of catches by country, fishing gear and area do not match exactly the total catches reported by species. However, for most of the cases, the discrepancies are minor.

Most of the figures are landings data, including minor amounts of discards that were reported. The data for recreational fishing that were reported are included. Swordfish data for the Pacific are not very complete and accurate, and hence no swordfish section was prepared for the Pacific.

4.2 GENERAL TRENDS

4.2.1 Total catch

Figure 4.1 shows the combined reported total catches of the major tunas for 1952–2000. The catch increased steadily from about 400 000 tonnes to a peak over 2 500 000 tonnes in 1998.

4.2.2 Catch by species

Figure 4.2 shows the catches in the Pacific by species, and Figure 4.3 the percentage species composition of the catch. The skipjack catch has been the largest almost throughout the period, and its share of the catches has increased from 35 to 50 percent. The next biggest catch is of yellowfin; it has been

FIGURE 4.1
Catches of major tuna species in the Pacific Ocean

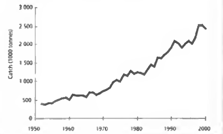


FIGURE 4.2
Catches of major tuna species in the Pacific Ocean, by species

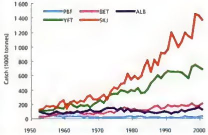


FIGURE 4.3
Species composition of the Pacific catches of major, tuna species

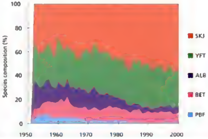
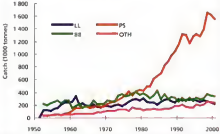


FIGURE 4.4
Catches of major tuna species in the Pacific Ocean, by fishing gear



increasing, and its share has remained stable at about 30 percent. The albacore catch has been stable, and hence its share has decreased. The bigeye catch has increased steadily, and its share has been stable at about 10 percent or slightly more. The bluefin catch has fluctuated very widely, while its share has declined steadily through the period.

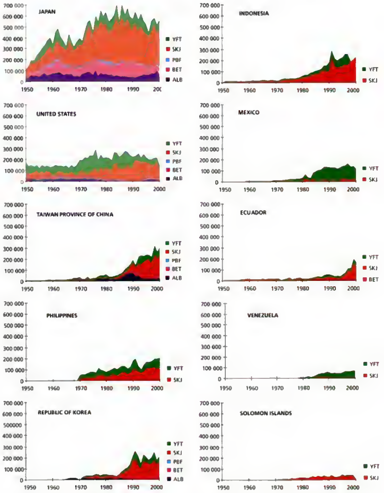
4.2.3 Catch by fishing gears

The catches of the main tunas in the Pacific during 1952-2000 are given in Figure 4.4. Until the early 1960s, baitboats caught the largest quantities of tunas, particularly skipjack and, to a lesser extent, yellowfin. In the eastern tropical Pacific, purse-seiners replaced baitboats during the 1960s, while in the central-western Pacific this did not happen until much later, and then only partially. Consequently the purse-seine catch increased very rapidly, from almost nil in 1950 to 1 700 000 tonnes in 1998, and since the 1980s has dominated the catches by all other gears; it now accounts for 60 to 70 percent of the total, both in the central-western and eastern Pacific. Most of the purse-seine catch consists of skipjack and yellowfin. However, baitboats are still important in the Pacific, unlike in other oceans: they are mostly traditional Japanese baitboats fishing for skipjack in the central-western Pacific.

The longline catch increased during the 1950s, and stabilized during the 1960s and early 1970s at around 150 000 tonnes. During this period there was a major change in the operational pattern of longline fishing, from targeting fish for the canning industry to targeting fish for the *sashimi* market. This became possible because of the development of super-cold temperature storage (below -40 °C) for fishing vessels. The hooks were also set at much greater depths after the change. This change caused some decrease in catch, since the catch rate for high-value tuna for *sashimi* is lower than that of low-value tuna for canning, but this decrease was compensated by the increasing trend in fleet size. Between the mid-1970s and early 1980s, the longline catch started increasing again due to the rapid development of new fleets such as those of Taiwan Province of China and the Republic

FIGURE 4.5

Pacific catches (tonnes) of major tuna species by the ten main fishing fleets



of Korea, as well as coastal longliners, and thereafter it has been stable at about 200 000 tonnes. Other fishing gears include traps, trolling, handlines and gillnets; also, many artisanal fisheries with unclassified gears have been conducted in the island states and in Southeast Asia.

4.2.4 Catch by country

The combined catches of the main tuna species from the Indian Ocean during 1950–2000 by the ten main fishing fleets are shown in Figure 4.5. **Japan** has been the leading nation in the tuna fisheries in the Pacific throughout the period. Its catches increased from 1952 to 1960, then stabilized at the level of about 300 000 to 400 000 tonnes. In the 1970s they started increasing again until the mid-1980s, to a maximum of nearly 700 000 tonnes. Since the late 1980s they have been declining. The catches include yellowfin, albacore, bluefin and bigeye by longliners, yellowfin, skipjack and bluefin by purse seiners, and skipjack and albacore by baitboats. In terms of quantity, skipjack constitutes more than 50 percent of the total catch.

The **United States** catch, mostly yellowfin and skipjack by baitboats in the eastern tropical Pacific, was stable at 100 000 to 150 000 tonnes during the 1950–60 period. However, when purse seiners replaced baitboats in the late 1960s and early 1970s, the catch started to increase, until the dolphin mortality associated with the fishery was restricted in the mid-1970s. Thereafter the catch has levelled off. Due to the problems of dolphin mortality and of the lower catch rates experienced during the El Niño in the early 1980s, an increasing part of the purse-seine fleet fishing in the eastern Pacific moved to the central-western Pacific, and now almost all the United States catch comes from the central-western Pacific.

The **Philippines**, **Indonesia** and the **Solomon Islands** started artisanal fisheries, mostly coastal longline fishing, in the 1970s, and those catches have been continuously increasing. **Taiwan Province of China** and the **Republic of Korea** started longline fisheries for yellowfin and albacore in the 1970s and 1980s, and the catch gradually increased, but since they started purse-seine fishing for skipjack and yellowfin in the 1990s the catch has increased rapidly.

In the eastern tropical Pacific, **Mexico**, **Ecuador**, **Venezuela** and **Vanuatu** started purse-seine fishing in the 1980s, using former United States and/or Spanish vessels. Their catch has been increasing rapidly in recent years.

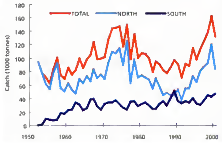
4.3 ALBACORE

4.3.1 General overview

It is considered that there are two stocks of albacore in the Pacific, one each in the southern and northern hemisphere; the species is not found in equatorial waters. The size of fish caught depends on the area of fishing, as the distribution of this species changes with age. Large adults inhabit tropical and subtropical waters between 25 °N and 25 °S, and small to medium fish are found at higher latitudes. Tagging data indicate that juvenile fish make extensive long-distance east-west migrations, and that they return to the spawning grounds in tropical and subtropical waters when they reach maturity. Spawning takes place where the sea-surface temperature is 24 °C or higher. Albacore are mainly caught by longlines, baitboats, trolling and gillnets. Medium- to large-sized fish are caught by longline; baitboat, troll and gillnet fisheries, operating mostly in temperate waters, catch small to medium fish.

FIGURE 4.6

Catches of albacore in the Pacific, total and by stock



The longline fishing grounds for albacore are widely distributed in the vast area of the ocean between 40 °N and 40 °S, except the area between 10 °N and 5 °S. There are two types of longline fleet, large-scale and small-scale. The Japanese baitboat fleet has been actively catching albacore in the temperate waters from south of Japan to north of the Midway Islands. Trollers from the United States and Canada operate in similar latitudes from north of the Midway Islands all the way to the west coast of North America. New Zealand and United States trollers have fished in temperate waters near the subtropical convergence zone in the southern hemisphere east of New Zealand. These surface fisheries operate during summer in each hemisphere, while longline fishing grounds in temperate waters are active during the winter season.

The total catch of albacore from the whole Pacific Ocean (Figure 4.6) was high, at about 140 000 tonnes, during the mid-1970s and during the most recent few years (1998–99), and lower during the 1950s and 1980s. Since the catch in the southern Pacific has been relatively stable around 30 000 to 40 000 tonnes and less than that for the northern Pacific, the trend in the total Pacific catch is a reflection of the northern Pacific catch, having fluctuated from 40 000 tonnes to over 180 000 tonnes.

Northern stock

The catch from the northern stock has been always higher than that from the southern stock, with the exception of 1990. The northern catch has relatively wide fluctuations: it varied between 50 000 and 100 000 tonnes in the 1950s and 1960s, then went up to almost 130 000 tonnes in 1977, but thereafter showed a sharp decline until the early 1990s. After hitting the bottom of 30 000 tonnes in 1992, it started to increase sharply, and recorded the highest catch in 1999.

Southern stock

The southern catch went from almost nil to around 30 000 tonnes by the early 1960s, and was stable at that level until the late 1980s. The highest catch of 50 000 tonnes was recorded in 1990, but has declined again to the level of a little less than 40 000 tonnes since then.

4.3.2 Catch by fishing gears

For the northern stock of albacore, the baitboat catch was the largest component until 1987 (Figure 4.7). The large increase in catch during the mid-1970s was due to the increase of the catch by this fishery. However, the baitboat share declined, and the longline catch has exceeded the baitboat catch since the late 1980s. The troll catch has also shown some decline since the mid-1970s. The catch by all gears except drift gillnets has shown concurrent increases since the early 1990s.

For the southern stock (Figure 4.8), more than 90 percent of the total catch has been taken by the longline fishery, except from the mid-1980s to early 1990s, when the drift gillnet catch dominated. The troll catch has increased during recent years, but has never exceeded 10 000 tonnes.

FIGURE 4.7
Catches of albacore in the North Pacific, by fishing gear

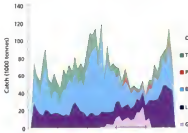
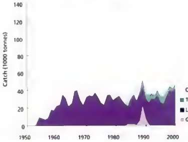


FIGURE 4.8
Catches of albacore in the South Pacific, by fishing gear



Longline fishing
The largest longline fleet has been operated by Japan. Its area of fishing has expanded since 1952. Initially, its target species were albacore and yellowfin for the canning industry.

Since the early 1970s, the fleet has shifted to targeting bigeye. The major reason for this was the increased demand for raw fish (sashimi) and the development of super-cold freezers for longliners, with which it became possible to freeze fish for sashimi-quality products. This tendency was more prevalent among the larger vessels, and they have operated in the eastern Pacific Ocean east of 160°W, while the small- to medium-sized boats have remained in the central-western Pacific.

The Korean longline fleet has been fishing in the tropical area of the central-western Pacific, while the Taiwanese longline fleet fished in the tropical to temperate waters of the southern hemisphere, where it targeted albacore.

Small-scale longline fisheries have been developed in various island states, using small boats that operate in the vicinity of their home countries. Such fisheries are found in Fiji, French Polynesia, American Samoa and Hawaii. China and the Federated States of Micronesia also operate such fisheries in the tropical western Pacific, but their albacore catch is very minor.

Troll fishery
The United States and Canadian troll fisheries in the North Pacific have a long history. Fishing takes place during the summer in the area that extends from north of the Midway Islands to off Canada. In the South Pacific, New Zealand and US boats have operated during the past 10 to 20 years. The fishing ground is generally located in the subtropical convergence zone between New Zealand and 140°W. The fishery catches pre-adult fish that are consumed canned.

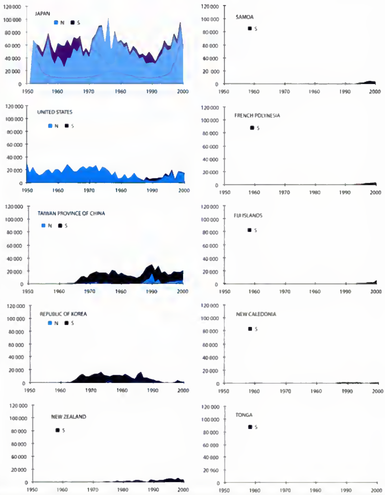
Baitboat fishery
Japan has operated a baitboat fishery in the western North Pacific for a long time. The fishing season is between May and October. Fishing starts to the south of Japan and gradually moves northeast. These boats also target skipjack, and switch target species from time to time, depending on the fishing and market conditions. The fish caught are mostly medium-sized (60–90 cm).

Other fisheries
Until the United Nations ban on high-seas drift gillnets became effective in 1992, a large-mesh drift gillnet fishery had existed in the temperate waters of the North Pacific since 1970s to 1991. In the South Pacific, a similar fishery had operated since the late 1980s, mostly in the Tasman Sea. Both these fisheries were operated by Japan, the Republic of Korea and Taiwan Province of China.

4.3.3 Catch by country

The albacore catches from the Pacific Ocean during 1952–2000 by the ten main fishing fleets are shown in Figure 4.9. The **Japanese** catches of albacore came mostly from the northern stock, and have two peaks at about 100 000 tonnes, one around the mid-1970s and the other around 2000, and two troughs at about 40 000 to 50 000 tonnes, one around 1970 and the other around 1990. The **United States** catch came mostly from the northern stock, and has been stable at around 20 000 tonnes except for a decline during the 1980s. The **Taiwanese** catch is minor in the north but relatively high in the south. It started in the mid-1960s, and is stable around 20 000 tonnes with some peaks around 1990 reflecting increases in the northern catch during that time. The **Korean** catch is almost exclusively from the south, and occurred mainly during 1965–90 at the level of about 10 000 tonnes. **New Zealand** has been catching albacore at a level of a few

FIGURE 4.9
Albacore catches (tonnes) by the ten main fishing fleets in the North and South Pacific



thousand tonnes since the mid-1970s. Starting in the mid-1990s, South Pacific island countries such as Samoa, French Polynesia, Fiji, New Caledonia and Tonga have been increasing their catches, though the level is still minor.

4.4 PACIFIC BLUEFIN TUNA

4.4.1 General overview

The spawning grounds of Pacific bluefin are assumed to be between the Philippines and southern Japan as well as in the Sea of Japan. No larvae have been reported in any other areas of the Pacific. Juveniles move northward from the spawning grounds and become available for the coastal troll fishery in the southern Japan at a size of about 20 cm. They make north-south migrations as they grow. Some fish undertake trans-Pacific migrations to the eastern Pacific when they reach about one or two years of age. These fish are thought to return to the western Pacific after one or two years. Adults appear to be distributed mainly in the north-western Pacific, but some are known to occur in other waters, since sporadic catches are recorded by the longline fishery in the far offshore area east of Japan and north of Hawaii, as well as off southern Australia and around New Zealand. Therefore, it is considered that there is only one stock in the entire Pacific Ocean.

FIGURE 4.10
Catches of Pacific bluefin: total, western and eastern Pacific

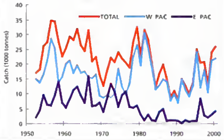


FIGURE 4.11
Catches of western Pacific bluefin, by fishing gear

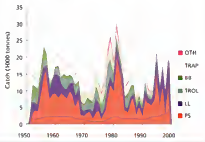
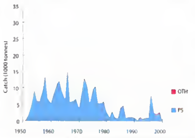


FIGURE 4.12
Catches of eastern Pacific bluefin, by fishing gear



The major fishing grounds for Pacific bluefin are located at the middle latitudes of the North Pacific between 20°N and 45°N in the west and between 23°N and 33°N in the east. In the northwestern Pacific, catches have been made by various gears in the waters from eastern Taiwan to northeastern Japan, including the East China Sea between Japan and the Republic of Korea and the Sea of Japan. In the eastern Pacific, bluefin are caught off Baja California and southern California, by purse-seine and sport fisheries.

The total catch for the whole Pacific Ocean since 1952 (Figure 4.10) has shown large fluctuations between 10 000 tonnes and 35 000 tonnes with lower catches during early 1950s, late 1960s to mid-1970s, and after the mid-1980s. The declines of catch seen before the 1980s were due to the decreased catches in the western Pacific but the decline after the mid-1980s was attributed to the very low catch in the eastern Pacific. The catch in the western Pacific generally exceeded that in the eastern Pacific. This is especially true for the years since 1980, as the eastern catch declined to a low level.

4.4.2 Catch by fishing gear

Both in the eastern and western Pacific, the largest catch has been made by the purse-seine fishery, followed by the longline, baitboat, troll and trap fisheries (Figures 4.11 and 4.12).

Longline fishery

Longline fishing targeting Pacific bluefin takes place only in the western Pacific. The Japanese longline fishery has the longest history, dating back nearly a hundred years. In general, the fishing season for small-scale longliners near Japan is summer in northern Japan and winter-spring in southern Japan. Until the 1970s, the catch by this fishing sector was significant. The catches by Taiwanese longliners were not significant (less than 700 tonnes) until 1996, but have gone up since then, reaching a record high of nearly 3 000 tonnes in 1999. These are large spawning-size fish, caught by coastal longliners in the waters around Taiwan Province of China and the Philippines between 122°E and 124°E. The fishing season starts in April and ends in June. The majority of the catch is exported to Japan.

In addition to these fisheries, there are some catches made by local longliners in Hawaii, Australia, New Zealand and other islands. The catches by these fleets have been very minor. Also, many Japanese large-scale longliners have fished in almost the entire Pacific except for the high latitudes of the central to the eastern Pacific in the southern hemisphere, targeting other species such as bigeye and yellowfin. Some sporadic catches of Pacific bluefin have been reported by these vessels fishing in these vast areas. Among those, relatively significant catches have been recorded in the North Pacific between 25°N and 35°N, as well as off Australia and New Zealand between 25°S and 40°S.

Purse-seine fishery

The largest Pacific bluefin catches are made by purse seiners in both the western and eastern Pacific. The largest purse-seine fishery is in Japan; it targets skipjack, yellowfin and Pacific bluefin around Japan, and a fishing unit is normally formed by a seiner plus scouting and transport boats. On the Pacific side of Japan, the season starts in June off central Japan and moves northeast as the season progresses, ending in early November in the waters between 35°N and 40°N. Generally, Pacific bluefin are not the most important species in terms of weight, but are probably most important in terms of value because of the high price paid for Pacific bluefin. Since 1981, a purse-seine fishery has operated in the Sea of Japan between 127°E and 136°E during the summer, as well as in the Tsushima Strait and East China Sea, mostly during fall to winter. The fish caught in the summer are generally adults, and those caught in winter are mostly juveniles (ages 0 to 2). The Korean purse-seine fleet has also been fishing since the mid-1980s in the waters between the Republic of Korea and Japan, as well as in the Yellow Sea, catching juveniles less than 100 cm long. The fishing season lasts from January to July, with the peak in March and April.

In the eastern Pacific, relatively small purse seiners fish for this species in the waters off Baja California and southern California. The majority of the catch is made between May and October.

Baitboat fishery

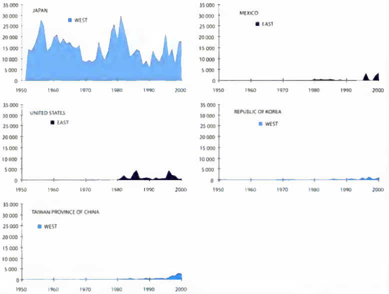
Only Japan operates a baitboat fishery for Pacific bluefin. The boats range from less than 5 GRT to nearly 200 GRT offshore, and those boats generally target skipjack.

Trap fishery

A trap fishery has existed for a long time in Japan, on both the coasts of the Sea of Japan and the Pacific. These traps are set not only for Pacific bluefin but for other species as well. The catch of Pacific bluefin is apparently influenced by the coastal oceanographic conditions. Consequently the catch showed large fluctuations between 2 000 and 6 500 tonnes until the beginning of the 1980s, and since then has decreased to less than 1 000 tonnes in recent years.

FIGURE 4.13

Pacific bluefin catches (tonnes) by the five main fishing fleets in the eastern and western Pacific



Other fisheries

The other types of fisheries known include trolling and gillnet fisheries in Japan. The fish caught are small, between 20 and 70 cm. Trolling is carried out by small boats in coastal waters in southern Japan, as well as in the East China Sea and Tsushima Strait. The gillnet fishery has operated in the Pacific Ocean off northeastern Japan.

4.4.3 Catch by country

Figure 4.13 shows the Pacific bluefin catches by five main fleets targeting this species in the eastern and western Pacific. The Japanese catch dominates, and usually accounts for more than 80 percent of the total. Since 1995, the catches by other fleets have increased.

4.5 BIGEYE TUNA

4.5.1 General overview

Data on bigeye catches in the Pacific by gear and area prior to 1962 are very incomplete, and hence the analyses of catches by gears and by areas are done only for the period of 1962–2000.

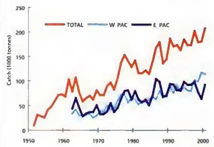
Bigeye tuna are caught by various gears, such as longline, purse seine and baitboat. Medium to large fish are targeted by longline, but this species is not of primary importance for the purse seine and baitboat fisheries, but is by-catch.

The longline fishing grounds for bigeye are widely distributed in the Pacific Ocean between 40°N and 40°S, while the purse-seine fleets operate in equatorial waters, roughly between 140°E–170°W and 130°W–80°W in the western and eastern Pacific, respectively.

Surface fisheries catch mostly juveniles, which form schools with other tunas (skipjack and/or yellowfin) in association with objects such as floating logs, sea mounts and large animals. As they grow older, bigeye tend to inhabit deeper waters and become less vulnerable to the surface fisheries. Spawning takes place in warm waters where the sea-surface temperature is 24 °C or higher. The stock structure is not yet very well understood; most likely there are two separate stocks in the east and west of the Pacific.

FIGURE 4.14

Catches of bigeye: total, western and eastern Pacific



The total bigeye catch for the whole Pacific Ocean (Figure 4.14) shows a rapid increase in the 1950s from 25 000 to 100 000 tonnes in the early 1960s. From the mid-1960s to 1975 it was stable at about 75 000 tonnes, but with an increasing trend. The increase accelerated after the mid-1970s up to almost 200 000 tonnes in recent years. Interestingly, catch tendencies and levels in the western and eastern Pacific are very similar, although the eastern catch has wider fluctuations than the western catch.

4.5.2 Catch by fishing gears

Figures 4.15 and 4.16 show the catches of bigeye, by fishing gears, in the eastern and western Pacific, respectively. As mentioned earlier, data by fishing gear are only available from 1962 to 2000. In both areas, longline catches were predominant by far until the late 1980s, but in recent years purse-seine catches have increased very rapidly, particularly in the eastern Pacific, and are now greater than the longline catches in the east. In the Pacific as a whole, the longline catch share went down to about 60 percent of the total in 2000; in that same year, purse seines and other gears accounted for nearly 25 percent and 15 percent, respectively, of the total.

FIGURE 4.15

Catches of bigeye in the eastern Pacific, by fishing gear

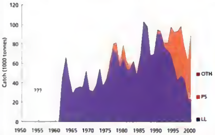
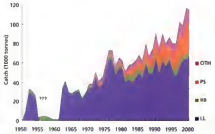


FIGURE 4.16

Catches of bigeye in the western Pacific, by fishing gear



In the eastern Pacific (Figure 4.15), there have been essentially two gears, longlines and purse seines. The longline catch dominated until 1992, and then declined. This decline has been replaced by the purse-seine catch, as stated previously, and the total catch was maintained at a relatively similar level.

Longline fishery
The catch by the small-scale longline fishery is air-freighted to fresh fish markets abroad. The large-scale longline fleet has been operated mostly by Japan.

Eastern Pacific: The longline catch, made almost exclusively by the Japanese fleet, with some minor catches by Taiwan Province of China, increased until 1987 to a peak of 100 000 tonnes, with fluctuations. However, it has declined, particularly in the 1990s, to the level of almost one-fifth of the peak, due to the reduction in fishing effort caused by the shift of boats to other areas and to a decline in the catch per unit of effort.

Western Pacific: Japanese large-scale longliners operated in the eastern Pacific east of 160°W, while the small to medium-sized boats fished in the western Pacific. The major fishing grounds are located in two bands of tropical waters running east-west, one north of the equator and the other in the south. Winter season fishing grounds are also found in the middle latitudes (centering on 30°) of both northern and southern hemispheres.

The Republic of Korea and Taiwan Province of China also maintained longline fleets. The Korean fleet fished in the tropical area of the central-eastern Pacific, while the Taiwanese fleet fished in the tropical to temperate waters of the southern hemisphere, targeting albacore. China also started longline fishing in the tropical central-western Pacific in the late 1980s.

More recently, longline fisheries have been developing in various island countries. The boats are small and operate in the vicinity of their home countries. Such fleets are found in Micronesia, Fiji, French Polynesia, American Samoa and Hawaii. High-quality fish are being air-freighted for the fresh fish market, and others are either consumed locally or deep-frozen and then exported.

Purse-seine fishery
Eastern Pacific: In the eastern Pacific, purse-seine boats replaced baitboats, the traditional tropical tuna fishing method, in the late 1950s to early 1960s. Starting around 1970, this fleet expanded further, and reached peak capacity in the late 1970s. Thereafter, it declined, with some fluctuations, but increased again in the late 1990s. These purse seiners set mostly on dolphin-associated tuna schools, and the catch of bigeye in this area had been small, less than 16 000 tonnes. However, when some boats started fishing on schools associated with FADs in 1993, the catch of bigeye immediately increased, to more than 50 000 tonnes by 1996, and has remained above 35 000 tonnes. The catch is made in a wide area between 10°N and 20°S, inter alia, between 5°N and 10°S from 80°W to 125°W.

Western Pacific: Japan initiated and developed a purse-seine fishery in the tropical waters of the central-western Pacific in the 1970s. The number of boats increased to the current level in the early 1980s. The United States, the Republif of Korea and Taiwan Province of China also developed their fisheries in the central-western Pacific during the early to mid-1980s. Fishing by US boats in this region began with the shift of part of the US fleet fishing in the eastern Pacific, due to the poor catch rates during the strong El Niño conditions in 1982–83. Since the mid-1980s, this fishery has expanded to include the waters of some Pacific island nations. Sets have traditionally been made on schools associated with naturally-occurring floating objects, as pioneered by the Japanese seiners, while other distant-water nations set mostly on free-swimming schools. In 1998 FADs were introduced, and have been used extensively since then. The amount of bigeye catch by seiners has not been well estimated in the past, because this species and yellowfin were landed together in most places and were sold at the same price. For this reason, the reported catch of bigeye is considered to be an underestimate. The area of operations for the Japanese fleet has been limited by the lack of access agreements with the coastal states, since most of the fishing areas are inside national EEZs, while the US fleet has free access to most waters under a multilateral

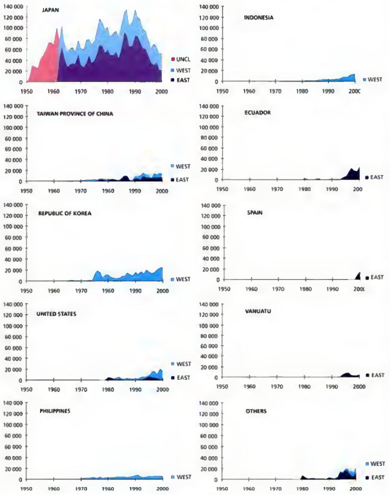


FIGURE 4.17
Bigeye catches (tonnes) by the nine main fishing fleets and all others combined in the eastern and western Pacific

agreement with island nations. The geographical extent of the catches are tropical waters between 10°N and 10°S from 135°E to 170°W.

Baitboat and other fisheries

Eastern Pacific: There are locally-based fleets in Hawaii, the continental United States and Mexico, but they are small, and hence the catches are minor.

Western Pacific: Japan has operated a large-scale baitboat fishery in the central-western Pacific, and a small-scale baitboat fishery around Japan during the summer-fall season. The bigeye catch is minor, as by-catch to skipjack. Catches from schools associated with floating objects contain more bigeye.

Other fisheries
In Indonesia and the Philippines, there are miscellaneous fisheries (small purse seine, jigging, hand-lining, etc) that catch bigeye. Most of them operate near FADs. Due to their artisanal nature and the non-existence of a data collection system, information on catches is limited.

4.5.3 Catches by country

The bigeye catches from the eastern and western Pacific Ocean during 1952–2000 by the ten main fishing fleets are shown in Figure 4.17 In general, the **Japanese** catch dominated all other countries, but its share has declined in recent years, due to the reduction of Japanese catch and the increase in catches by other fleets.

In the western Pacific in the last several years, Japan accounted for 27 percent of the total, followed by the **Republic of Korea** (22 percent), the **United States** (14 percent), **Indonesia** (13 percent), **Taiwan Province of China** (8 percent) and the **Philippines** (6 percent). In the eastern Pacific, Japan's share was more than 90 percent until 1992. However, it then started declining, and fell to about one-third of its 1992 level.

4.6 SKIPJACK TUNA

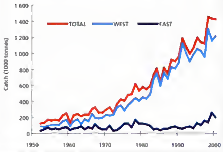
4.6.1 General overview

Skipjack are caught almost entirely by surface gears such as purse seine and baitboat. The fishing is conducted in both the eastern and central-western Pacific, but the catches in the west are much greater than in the east. Fishing was initiated by baitboats in both areas, but in the eastern Pacific this fishery was soon replaced by the purse-seine fishery, while baitboats continued operating in the central-western Pacific. Skipjack form schools associated with objects such as floating logs and large animals. Spawning takes place in vast areas of the Pacific where the surface temperature is 24°C or higher. It is considered that there are at least two stocks in the Pacific, eastern and western, and possibly others in the southeast and other areas.

Baitboat fisheries operate in the central-western Pacific, including off Japan. There are similar fisheries in the Pacific island countries, but they are conducted on a smaller scale. The purse-seine fleets operate in equatorial waters on both sides of the Pacific, roughly between 140°E and 170°W and 130°W and 80°W, respectively. Miscellaneous gears are used in the Philippines and Indonesia, including handlines, trolling and small seine nets.

Figure 4.18 shows the total, western, and eastern Pacific skipjack catch during 1952-2000. It shows a general continuous increasing trend throughout the period, slower at the beginning and faster in more recent years. At the beginning of this period catches were about 100 000 tonnes; they passed 500 000 tonnes during the mid-1970s and reached more than 1 000 000 tonnes in the early 1990s.

FIGURE 4.18
Catches of skipjack: total, western and eastern Pacific



The catch in the central-western Pacific has been much larger than that of the eastern Pacific, and represented about 80 percent of the total catch in recent years. The catch in the eastern Pacific has fluctuated, and showed little increase except for some gradual increase since the mid-1990s.

4.6.2 Catch by fishing gears

Figures 4.19 and 4.20 show skipjack catches during 1952–2000 in the central-western and eastern Pacific, respectively, by fishing gears. Until the early 1980s, the catch in the central-western Pacific was made exclusively by the baitboat fishery. Thereafter, the purse-seine catch has increased greatly, and is now about three times larger than the baitboat catch. The catch by other gears is mostly made by various fisheries in many countries, including the Philippines and Indonesia often without gear specification.

In the eastern Pacific, the baitboat catch has been negligible since the early 1970s, and purse seines make nearly all the catches. The annual catch has been more than 200 000 tonnes since 1999, the highest level.

FIGURE 4.19
Catches of skipjack in the western Pacific, by fishing gear

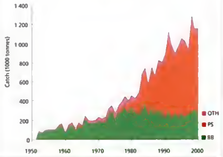
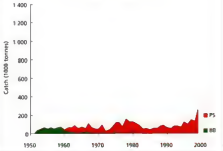


FIGURE 4.20
Catches of skipjack in the eastern Pacific, by fishing gear



Baitboat fishery

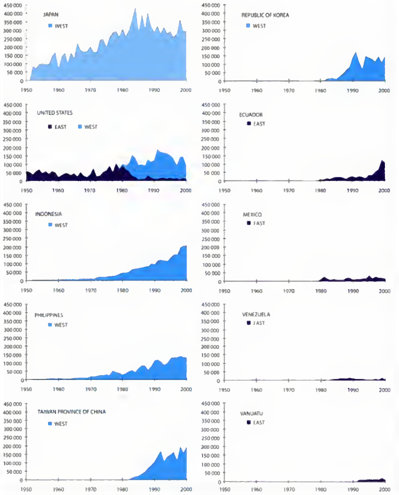
Western Pacific: Japan has operated a fishery by large-scale boats in the central-western Pacific targeting skipjack, and a similar fishery around Japan during the summer-fall seasons with small to medium-sized boats. There are locally-based fleets in the Pacific island countries such as Fiji and the Solomon Islands. Fisheries were developed in Palau and Papua New Guinea, but have diminished their fishing since the mid-1980s.

Eastern Pacific: Until the 1960s the United States had a baitboat fishery for tropical tunas in the eastern Pacific, but this was replaced by purse seiners during the 1960s.

Purse-seine fishery

Western Pacific: Japan initiated and developed the purse-seine fishery in the tropical waters of the western Pacific. The number of boats increased to the current level in the early 1980s. The United States, the Republic of Korea and Taiwan Province of China also developed their fisheries during the early to mid-1980s. The US fishery was initiated by seiners moving from the eastern Pacific because of poor catch conditions during the El Niño of 1982-1983. Since the mid-1980s, the fishery has expanded to include some Pacific island nations such as Micronesia, Papua New Guinea and Kiribati. Japan made sets traditionally on schools associated with natural floating objects, while other distant-water nations set mostly on free-swimming schools. FADs were introduced in 1998, and have been used extensively used since then. Skipjack accounts for more

FIGURE 4.21
Skipjack catches (tonnes) by the ten main fishing fleets in the eastern and western Pacific



than 70 percent of the total catch of the purse-seine fishery. As with bigeye, the area of operations for the Japanese fleet has been limited by the lack of access agreements with the coastal states, since most of the fishing areas are inside national EEZs, while the US fleet has free access to most waters under a multilateral agreement with island nations. The geographical extent of the catches are tropical waters between 10°N and 10°S from 135°E to 170°W.

Eastern Pacific: In the eastern Pacific, purse-seine boats, mostly from the United States, replaced baitboats during the late 1950s and early 1960s. Starting around 1970, the carrying capacity of the fleet expanded until it reached a peak in the late 1970s. Thereafter it declined somewhat, with some fluctuations, but increased again in the late 1990s, but with seiners of other countries. The catch of skipjack is much smaller than that of yellowfin, partly because they target yellowfin as the first priority and many purse seiners set their nets on schools associated with dolphins, which are mostly composed of large yellowfin. The skipjack catch in this area has been increasing in recent years due to the increase in the use of FADs. The catch is obtained in a wide area of the eastern Pacific Ocean between 10°N and 20°S, inter alia, between 5°N and 10°S, 80°-125°W.

Other fisheries
In Indonesia and the Philippines, there are miscellaneous fisheries (small purse seines, trolling, handlining, etc) that catch skipjack. Most of them operate around FADs. Due to their artisanal nature and the lack of a data collection system, precise information on catches has not been available.

4.6.3 Catch by country

The skipjack catches from the Pacific Ocean during 1950-2000 by the 10 main fishing fleets are shown in Figure 4.21, by east and central-western area. **Japan's** catch, all from the central-western Pacific, dominated throughout the period, but its share has been decreasing since the early 1980s, as the Japanese catch has been decreasing slightly while those by other nations have been increasing. Those include purse-seine catches, by the **United States**, the **Republic of Korea** and **Taiwan Province of China** in the central-western Pacific and **Ecuador, Mexico, Venezuela** and **Vanuatu** in the eastern Pacific, and artisanal fisheries by **Indonesia** and **Philippines**.

4.7 YELLOWFIN TUNA

4.7.1 General overview

Yellowfin tuna are caught by various gears, such as purse seines, longlines and baitboats. Until the development of the purse-seine fishery, most of the catches were made by longlines, which take medium to large-sized fish, as one of the main target species. Although in the western Pacific the purse-seine catch has been less than that of skipjack, yellowfin is very important for the fishery both in terms of quantity and economic value. On the other hand, in the eastern Pacific yellowfin have been the primary component of the catch in the purse-seine fishery. After the purse-seine fishery had developed fully, its catch has been far greater than those of other fisheries. Juveniles form schools in association with other tunas or objects such as floating logs and large animals. Adults are also found in schools, either free-swimming or associated with other tunas. However, it is only in the eastern Pacific that schools of large yellowfin are frequently found associated with herds of dolphins. Spawning takes place in the vast areas of the Pacific where the sea surface temperature is 24 °C or higher. There are most likely two stocks in the Pacific, one in the east and one in the west.

FIGURE 4.22
Catches of yellowfin: total, western and eastern Pacific

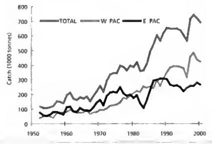


Figure 4.22 shows the catches of yellowfin in the entire Pacific and in the eastern and central-western Pacific. The total catch for the whole Pacific Ocean has shown a general increasing trend

throughout the 1952–2000 period. Two important increases occurred, in the late 1960s and the mid- to late 1980s.

Until the late 1960s the catches in the east and west were at almost the same level. In the 1970s the catch in the east was much higher than in the west, but since the late 1970s the western catch has been larger than the eastern catch, and has continued to increase to 450 000 tonnes, while the eastern catch has been stable around 200 000 tonnes.

Eastern Pacific: In the eastern Pacific, most of the catch was by surface gears, originally baitboats and, since the mid-1970s, purse seines. The current catch of 270 000 tonnes is close to the highest historical level.

Central-western Pacific: In the western Pacific, most of the catch was made by longliners until the mid-1970s. In the early 1980s, the catch by the purse-seine fishery expanded sharply, and exceeded the longline catch in the mid-1980s. It has continued to increase and has been at the level of about 200 000 tonnes since the early 1990s. The longline catch has been stable between 50 000 and 110 000 tonnes since the 1950s. The catches by other gears, which are mostly made by various fisheries in the Philippines and Indonesia, also show increasing trends, and the recent catches of this category are larger than the longline catch.

4.7.2 Catch by gear

Figures 4.23 and 4.24 show the catches of yellowfin, by fishing gears, in the eastern and western Pacific, respectively.

FIGURE 4.23
Catches of yellowfin in the eastern Pacific, by fishing gear

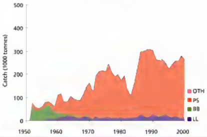
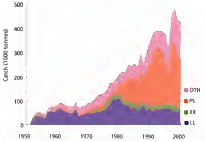


FIGURE 4.24
Catches of yellowfin in the western Pacific, by fishing gear



Longline fishery

The longline fishing grounds are widely spread in vast areas of the Pacific Ocean between 40°N and 40°S, with the catch rates being higher in the central-western Pacific. For the longliners operating in the western tropical Pacific, yellowfin has been the primary species, while it has been of secondary importance for those operating in other areas.

The largest fleet has been operated by Japan. At the initial stage of this fishery, the target species were albacore and yellowfin for canning. Since the early 1970s the fleet has shifted to targeting bigeye for the sashimi market, with the development of super-cold freezer. This shift of target species was more obvious with the larger boats which operated in the eastern Pacific east of 160°W. Small to medium sized boats have operated in the central-western Pacific. The major fishing grounds are located in two bands of tropical waters running east-west, one north of the equator and the other in the south. Winter fishing grounds are also found in the middle latitudes (centering on 30°) of both northern and southern hemispheres.

The Republic of Korea and Taiwan Province of China also maintained large-scale longline fleets. The Korean fleet has fished in the tropical area of the central-eastern Pacific, while the Taiwanese fleet fished in the tropical to temperate waters of the southern hemisphere, targeting albacore.

Recently longline fisheries are developing in the island countries. The boats are small, and operate in the vicinity of their home countries. Such fleets are found in Micronesia, Fiji, French Polynesia, American Samoa and Hawaii. China also has been fishing in the tropical western Pacific since the late 1980s. High-grade fish in the catches of these small longliners are air-freighted to fresh fish markets, while others are either consumed locally or deep-frozen on land and then exported.

Purse-seine fishery

The purse-seine fleets operate in the equatorial waters of both the western and eastern Pacific, roughly between 140°E and 170°W and 130°W and 80°W, respectively.

In the **eastern Pacific**, purse-seine boats replaced baitboats in the late 1950s and early 1960s. Starting around 1970, this fleet expanded further, reaching a peak in the late 1970s. The catch also reached a peak of more than 200 000 tonnes in 1976, most of it made on dolphin-associated schools. Thereafter it started declining, due mostly to restrictions on the mortality of dolphins associated with tuna schools, although poor catch rates caused by severe El Niño conditions also contributed. At this time many US seiners moved to the central-western Pacific. The catch increased sharply in the mid-1980s to a new high level of 300 000 tonnes, and stayed high until recently. The catches are made in a wide area of the eastern Pacific between 10°N and 20°S, inter alia, between 5°N and 10°S, 80°-125°W.

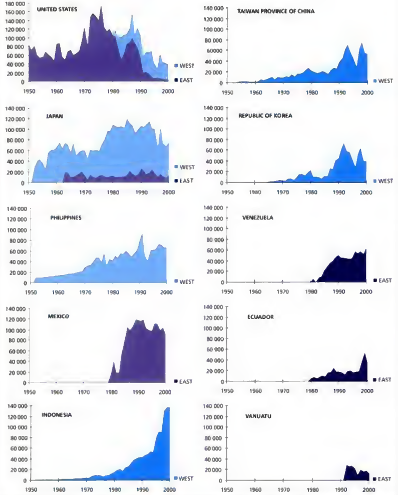
Japan initiated and developed the purse-seine fishery in the tropical waters of the **central-western Pacific**. The number of boats increased to the current level in early 1980s. The United States, the Republic of Korea and Taiwan Province of China also developed their purse-seine fisheries during early to mid-1980s. Fishing by US boats in this region began with the shift of part of the US fleet fishing in the eastern Pacific, due to the poor catch rates during the strong El Niño conditions in 1982-1983. Since the mid-1980s, this fishery has expanded to include the waters of some Pacific island nations. Sets have traditionally been made on schools associated with naturally-occurring floating objects, as pioneered by the Japanese boats, while other distant-water nations set mostly on free-swimming schools. In 1998 FADs were introduced and have been used extensively since then.

Yellowfin and bigeye in purse-seine catches were often not separated at the time of landing, and were sold at the same price, mostly as yellowfin. For this reason, the reported catch of yellowfin is considered to have been over-estimated. The area of operations for the Japanese fleet has been limited by the lack of access agreements with the coastal states, since the majority of the fishing areas are inside national EEZs, while the US fleet has free access to most waters under a multilateral agreement with island nations. The geographical extent of the catches are tropical waters between 10°N and 10°S, 135°E and 170°W.

Baitboat fishery

Japan has operated a baitboat fishery in the central-western Pacific with large boats. As their target is skipjack, the catch of yellowfin has been minor. Japan also operates a baitboat fishery around Japan during the summer-fall season with small to medium-sized boats. In the eastern Pacific, baitboats were one of the major gears for yellowfin until having been replaced by purse seines in the early 1960s. There are locally-based fleets in Hawaii, the continental United States and Mexico, but they are small, and hence the catch has been minor in recent years.

FIGURE 4.25
Yellowfin catches (tonnes) by the ten main fishing fleets in the eastern and western Pacific



Other fisheries

In Indonesia and the Philippines there are miscellaneous fisheries (small purse seine, jigging, handlining, etc.) that catch yellowfin. Most of them operate around FADs. Due to their artisanal nature and the absence of a data collection system, precise information on catch has not been available.

4.7.3 Catches by country

The yellowfin catches from the eastern and western Pacific Ocean during 1950-2000 by the ten main fishing fleets are shown in Figure 4.25. The **United States** catch dominated in the eastern Pacific until the early 1980s, but then the catch in the central-western Pacific started increasing while the eastern Pacific catch fell to almost nil in 2000. In its place, the **Mexican** catch started increasing very rapidly in the eastern Pacific in 1981, and has been over 100 000 tonnes since 1985. **Japan** had been the largest producer of yellowfin in the central-western Pacific, but the **Indonesian** catch increased very rapidly after 1980 and since 1997 has been the largest producer of yellowfin, reaching more than 130 000 tonnes. The **Philippines** catch increased continuously from 1952 to about 100 000 tonnes in 1990; it dropped once in 1992 and 1993, but since 1994 has been at a high level of about 60 000 tonnes. The **Republic of Korea** and **Taiwan Province of China** in the central-western Pacific, and **Venezuela**, **Ecuador** and **Vanuatu** in the eastern Pacific, have all increased their catches very rapidly in the last 10 to 20 years.

5. Development of southern bluefin tuna fisheries

5.1 GENERAL OVERVIEW

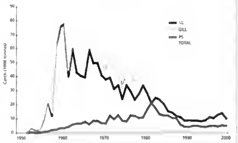
Southern bluefin tuna are distributed only in the southern hemisphere, and mainly inhabit cold waters around 40°S. However, their spawning grounds are in tropical waters, south of Java. This is a unique species of tuna, in that one stock is distributed throughout the three major oceans, Pacific, Indian and Atlantic. For this reason, the description of southern bluefin tuna is not presented under each ocean but in a separate section.

Figure 5.1 shows the total catch of southern bluefin tuna and catch by fishing gears. This species has been caught since the early 1950s, at first in tropical waters. Southern bluefin tuna have been subject of management by ICCAT since 1969, and by the CCSBT since its establishment in 1994. As the Atlantic Ocean covers only a very minor part of the distribution of southern bluefin tuna, and only Australia, Japan and New Zealand used to catch this species, in the 1980s ICCAT decided to leave the management of the species to trilateral agreements among these countries and now to the CCSBT.

The major fishing countries have been only Australia and Japan. The Australian fishery has used several gears, including baitboats, purse seines, and trolling gear. The Japanese fishery uses only longlines. The catch of southern bluefin tuna was around 12 000 to 15 000 tonnes in the 1950s, and was used mostly for canning. When Japanese longliners adopted super-cold freezers and started fishing for the *sashimi* market, southern bluefin tuna acquired a high value in their market, as a substitute for (northern) bluefin tuna. Consequently the catch increased suddenly to a peak of 80 000 tonnes in 1961, after which it gradually decreased to about 40 000 tonnes in the early 1980s, due mostly to a decline in the catch rate. In the early 1980s a quota system was introduced under a trilateral agreement among Australia, Japan and New Zealand. The annual quota has been reduced since then, as reflected by a sharp decline of the catch, and by the early 1990s had been reduced to less than 10 000 tonnes. The quota has been decided by the CCSBT since its establishment in 1994, and was kept at around 13 000 MT in the 1990s. The total catch started increasing again in the late 1990s due to the increase of catches by non-member fleets of CCSBT, i.e. the Republic of Korea, Taiwan Province of China and Indonesia.

FIGURE 5.1

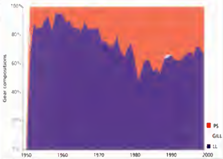
Total world catch of southern bluefin tune, and catch by fishing gear



5.2 CATCH BY FISHING GEARS

The gears used to harvest southern bluefin tuna have been either longlines or surface gears (mainly purse seines,

FIGURE 5.2
Percentages of total world catch of southern bluefin tuna, by fishing gear



baitboats and trolling, although drift gillnets were used in the 1980s, by Taiwan Province of China only). Surface gears are used only by Australia; all the other countries use longlines.

Figure 5.2 shows the proportions of the catches made by each fishing gear. In the 1950s, almost 90 percent of the catches were made by longlines. However, the share by surface gears increased until the early 1980s as the Australian fisheries developed. From the early 1980s, when quota regulations started, these proportions remained stable until the 1990s. The longline share started to increase further when non-member fleets of CCSBT started fishing with longlines, which were made outside of the quota.

5.2.1 Longline fishery

Longline catches of southern bluefin tuna increased with the development of the Japanese fishery, to the peak of 78 000 tonnes in 1961. After that they gradually decreased to around 9 000 tonnes in the early 1990s, but increased again to 14 000 tonnes in 1999 due to the catches by the Republic of Korea, Taiwan Province of China and Indonesia.

5.2.2 Drift gillnet fishery

Taiwan Province of China operated a drift gillnet fishery in the southern hemisphere, mainly in the Tasman Sea and the South Pacific, from 1982 to 1992. The main target species was albacore, but southern bluefin tuna were a secondary target. Catches were between 10 tonnes and 300 tonnes. The fishery ceased in 1992 with the 1991 UN ban on large pelagic driftnets.

5.2.3 Surface fisheries

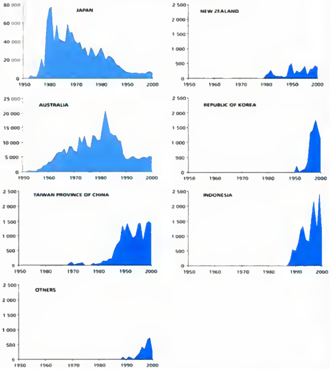
Australia is the only country catching southern bluefin with gears other than longlines or gillnets. These surface fisheries have used several gears, including baitboats, purse seines and trolling gear. The major fishery catching southern bluefin tuna changed historically: in the early period, until the 1980s, baitboats were the major gear, but they were replaced by purse seines in the 1980s. The surface catch increased as the fishery developed, and peaked at over 20 000 tonnes in 1982. Thereafter the catch showed a decline, due to the shrinking quota regulations.

5.3 CATCHES BY COUNTRY

Figure 5.3 shows the world catches of southern bluefin tuna by country. As the magnitudes of the catch are so different among the countries, three different scales are used, one for Japan, one for Australia and the other for all other countries; this is different to all the other species and stocks in this report.

Japan and Australia have been the two major countries fishing for southern bluefin tuna. **Japan** started its longline fishery in the early 1950s; the catch increased rapidly to 78 000 tonnes in 1961, and then gradually decreased to around 30 000 tonnes in the late 1970s. It decreased continuously in the 1990s to around 6 000 tonnes due to the quota agreed by the trilateral agreements and the CCSBT.

FIGURE 5.3
World catches (tonnes) of southern bluefin tuna, by country
(Note: scales are not the same for all countries)



Australia has been catching southern bluefin tuna with baitboat, purse-seine and troll fisheries. The fisheries started in the early 1950s, and the catch increased gradually to a peak of over 20 000 tonnes in 1982. It then decreased suddenly to a level of 6 000 tonnes in the 1990s, in line with the agreed quota, as stated above. All these gears catch relatively small juvenile tuna near coasts, and the catch used to be provided to the canning industry. However, because of the high price paid in the Japanese market for southern bluefin, some of the fish caught by these surface gears had also been exported to Japan, even though the price paid for small fish was far inferior to the large fish taken by longliners. In the late 1980s fish farming started: juvenile tunas are kept in cages and fattened for a few months before being shipped to the Japanese market. Since fish with high fat content, although small, fetch high prices, most of the fish caught by Australia are now fattened in the cages and exported.

New Zealand started longline fishing in 1980. The catch increased to the peak of 529 tonnes in 1990, and has fluctuated between 150 and 500 tonnes in recent years. **Taiwan Province of China** started catching southern bluefin tuna in 1969 with longlines, and also operated a drift gillnet fishery in the southern hemisphere from 1982 to 1992.

Their total catch increased in the 1980s to more than 1 400 tonnes, and stayed at a similar level in the 1990s. The drift gillnet catch was small, between 10 and 300 tonnes. The **Republic of Korea** started a longline fishery for southern bluefin tuna in 1991, and catch increased rapidly to 1 600 tonnes in 1998, but then dropped to 987 tonnes in 2000. **Indonesia** started longline fishing for southern bluefin tuna in 1986; the catch has increased continuously to 2 500 tonnes in 1999.

This paper reviews historical trends of the catches of the major commercial species (albacore, bigeye, bluefin, skipjack and yellowfin) of tunas. The total world catch of these species has increased during the last 50 years (from 0.4 to 3.9 million tonnes), but the pattern of increase has varied among species, oceans and fishing gears. The causes of those variations are analysed in this paper. In the world catch, the Pacific Ocean has been predominant throughout. In recent years catches from the Indian Ocean have exceeded those from the Atlantic. Skipjack and yellowfin catches have shown a rapid increase. Bigeye catches have also shown a constant increase, but at a lower level. The catches of albacore, bluefin and southern bluefin tunas have been stable or have decreased in recent years. The baitboat fishery took the greatest proportion of the total catches during the 1950s. However, the catch of the purse-seine fishery became significant in the late 1950s and dominant by 1990. Longline catches started picking up in the late 1950s, increased until the 1990s and thereafter declined.

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